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HOLISTIC SURVEY OF A DEGRADED SOILSCAPE FROM EASTERN ROMANIA: HYPOTESIS OF RECLAMATION AND SOCIAL-ECONOMICAL DEVELOPMENT

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Introduction

If you decide to visit Tutova Hills, you will see only poverty. When you see how these people live, when you see their homes, as they perform agriculture, their standard of living, you'll think this is the land cursed by God... Your mind guides you immediately to the Genesis from the Holy Bible... a land which, though worked with toil, gives those people only thistles and weeds:

Genesis 3, 17-18-19

17 *«Because thou hast hearkened unto the voice of thy wife, and hast eaten of the tree, of which I commanded thee, saying, Thou shalt not eat of it: cursed* is *the ground for thy sake; in sorrow shalt thou eat* of *it all the days of thy life;*

18 *Thorns also and thistles shall it bring forth to thee; and thou shalt eat the herb of the field;*

19 *In the sweat of thy face shalt thou eat bread, till thou return unto the ground; for out of it wast thou taken: for dust thou* art, *and unto dust shalt thou return».*

17 *«Poiché hai dato ascolto alla voce di tua moglie e hai mangiato dell'albero circa il quale io ti avevo comandato dicendo: "Non ne mangiare", il suolo sarà maledetto per causa tua; ne mangerai il frutto con fatica tutti i giorni della tua vita.*

18 *Esso ti produrrà spine e triboli, e tu mangerai l'erba dei campi;*

19 *mangerai il pane col sudore del tuo volto, finché tu ritorni alla terra perché da essa fosti tratto; poiché tu sei polvere, e in polvere ritornerai».*

In the last 20 years, in Romania, particularly in the Eastern part, unreasonable, uncontrolled and aggressive actions of the anthropogenic factors corroborated with soil erosion, accentuated the processes of environmental degradation and decreased the productive potential of the ecosystems. Also, the concern for the reclamation of the total quality of these lands at local levels were almost absent, as well as the allocated funds. Therefore, the climatic, pedological, geological and anthropogenic degradation has been increased, amplified and became acute, requiring complex researches according to the protection and conservation of soil quality and biodiversity.

Many landscapes are highly sensitive to the environmental changes. The soil (as an open dynamic system, living organism and non-renewable resource), is the crucial element in the functioning of the biosphere that records these changes which leads to rapid and often irreversible degradation of the ecosystems. Understanding the relationships between soils and human induced environmental changes is a major priority that requires hypothesis of reclamations that lead to sustainable land management from the environmental and economic point of view.

In eastern Romania, the Tutova Hills area is considered the poorest in the European Union, being dubbed the “poverty pole” in Europe.

Consequently, the question is: Could be possible to improve the soil status and the life condition of the inhabitants of this area in some way? With this thesis we will try to give an answer this question!

This thesis starts from a practical necessity, generated by the need to develop hypothesis of reclamation and social-economical development in Tutova Hills.

To highlight the critical issues, we considered mandatory a holistic approach based on complementary studies of agriculture, soil, forestry, biology, ecology, geography, sociology, economics. All these aspects were developed in the 2011-2014 period, of the whole area of Tutova Hills.

In particular we stressed the aspects concerning:

- the assessment of land degradation in the Southern part of Pereschiv basin, in the wider context of the Tutova Hills;
- the development of hypotheses for the rehabilitation of degraded lands in the study area;
- the application of a sociological approach for assessing the living standard of the population in the Tutova area.

Acknowledgements: I address respectfully and warmest thanks to *Professor Carmelo Dazzi and Professor Giuseppe Lo Papa* from University of Palermo, Italy, for excellent scientific guidance and harmony during elaboration of this PhD Thesis. Also, I express my gratitude to *Dr. Geanina Bireescu* and colleagues from the Institute of Biological Research Iaşi, Romania for their scientific support.

1
Soil degradation and sustainable development in a global context

In 1987, the Brundtland Report of the United Nations Commission on Environment and Development (UCED), adopted the following definition of sustainable development: *"a development that satisfies the requirements of the present without compromising the ability of future generations to meet their own needs"*.

Sustainable development ensures economic growth by natural resources management measures that do not degrades the soil quality.

At the Conference in Rio de Janeiro in 1992 the concept of sustainable development was transferred, from the research field, in the field of economic, social and political interests of harmonization, monitoring and evaluation of anthropogenic impact on the environment.

Green Summit in Johannesburg in 2002, established that sustainable development requires a long-term involvement of policy makers in taking and implementing appropriate and necessary measures.

The concept of sustainable development is interdisciplinary and integrative. Sustainability is an attribute of a system to exist in a preferential status which allows it to maintain its productive capacity over time (Clayton *and* Radcliffe, 1996). Consequently, the United Nations Commission on Sustainable Development (CSD) has developed a system of indicators, called: Pressure Indicators – Status Indicators - Response Indicators (Pressure-state-response framework, after Hens, 1996), in order to assess the sustainable development of an ecological area (Figure 1).

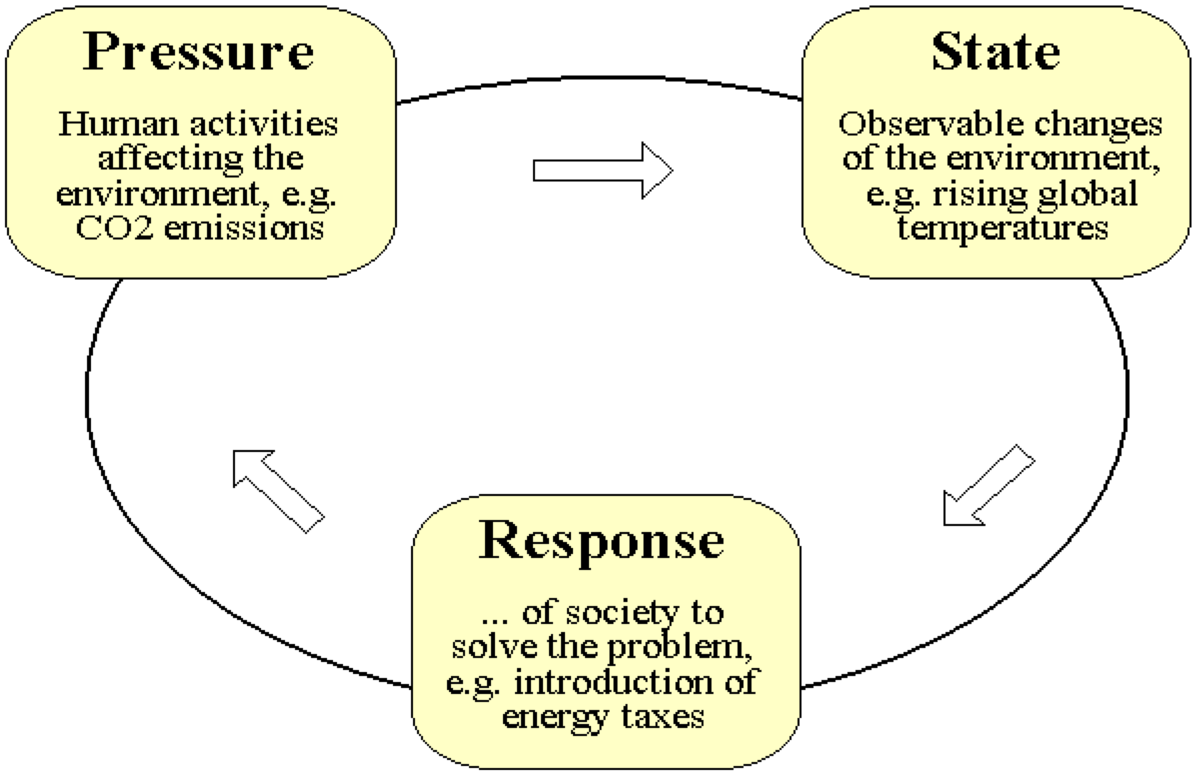


Figure 1. The Pressure-state-response framework (after Hens, 1996)

Pressure indicators highlights the impact of one or more social, economic and natural factors on the environment and they are essential in formulating sustainable development policies.

Status indicators shows the changes or the current status of the environment.

Response indicators outlines the measures to solve the environmental problems (eg. reducing pollution, soil erosion, etc.).

1. 1. Soil resources

The land surface of the Earth totals 13 069 billion hectares, of which 1,5 billion hectares are unused wasteland and 2,8 billion hectares are unused but largely inaccessible (Oldeman, 1994).

Of the 8,7 billion hectares under use, the most are suitable only for grasslands, permanent vegetation, forests or woodlands. Only 3,2 billion hectares are potentially arable (Tables 1 and 2).

About half of arable land is currently cropped, and 41% is considered moderately-highly productive (Buringh *and* Dudal, 1987).

Table 1. Global supply and use of land (after Buringh *and* Dudal, 1987)

Type of land	Area (billion ha)
Total ice-free land area in the World	13,4
Total land area without water bodies	13,0
Land used	8,7
Potentially arable land	3,2
Moderatelly to highly productive	1,3
Low productive land	1,9
Current use of potentially arable land	3,2
Cropland	1,5
Permanent pasture, forest are woodland	1,7

Table 2. Trend global arable land (10^6 ha) (after Lal, 2008)

Year	Arable land	Grazing land	Pasture
1700	265	6860	-
1850	537	6837	-
1920	913	6748	-
1950	1117	6789	-
1980	1346	6788	3244
1990	1396	-	3368
2000	1398	-	3442

Between 1995 and 2020 year period, global population is expected to increase by 35%, reaching 7,7 billion people (FAO, 1996, Scherr Sara, 1999), of which 84% will be registered in developing countries.

It is estimated that, in 2015, 94% (around 3 billion people) of the world's rural population will be in the developing countries, (United Nations 1995 *and* 1996, Scherr Sara, 1999).

The request for food and other products from cultivable land will increase, and per capita landholdings in developing countries will decline from 0,3 hectares in 1990 to 0,1-0,2 hectares in 2050 (FAO, 1993), to particularly low levels in Asia and North Africa, which are expected to reach such a level of land pressure by 2025 (Table 3).

Table 3. Current and projected levels of cultivable land
(Morse *et al.*, 1992, Scherr Sara, 1999)

Region	Per capita landholdings	
	1990	2025
Sub-Saharian Africa	1,60	0,63
West Asia and North Africa	0,22	0,16
Rest of Asia/without China)	0,20	0,12
Central and South America	2,00	1,17

1. 2. Decline of soil quality

Probably the most comprehensive definition of soil quality was published by the Soil Science Society of America's Ad Hoc Committee on Soil Quality as "*the capacity of a specific kind of soil to function, within natural or managed ecosystem boundaries, to sustain plant and animal productivity, maintain or enhance water and air quality, and support human health and habitation*" (Karlen et al., 1997).

According to current practices of intensive agriculture, the food production has increased and will greatly increase by massive inputs in agricultural production systems, so, there is an increase in environmental pollution and degradation of natural and non-renewable soil resources (Huber *et al.*, 2001, 2008; Bireescu *et al.*, 2010). After Doran (2000), the greatest challenge is to maintain the equilibrium within ecosystems and to establish the priorities between food production, energy and trophic potential of soil resources. In this context, *soil quality* is an important dimension in relation to preservation and health strategies, good agricultural practices and the sustainability of terrestrial ecosystems.

Soil quality depends on a large number of physical, chemical, biological, microbiological and biochemical properties, the last two being the most sensitive because they respond rapidly to changes (Dick *and* Tabatabai, 1993; Trasar-Cepeda *et al.*, 1998; Ros *et al.*, 2003; Bastida *et al.*, 2008; Abellan *et al.*, 2011). Based on this, there are three types of soil quality: soil physical quality, soil chemical quality and soil biological quality. As physical features we can mention soil texture, air porosity and bulk density. The chemical features are soil reaction (pH), electro-conductivity, alkality (the presence of Na^+ in soil), the content of total nitrogen, available phosphorus, exchangeable potassium, SOM (soil organic matter) and base saturation. The soil biological quality are determined by indicators such as:

- Indicator of Vital Activity Potential (IVAP);
- Indicator of Enzymatic Activity Potential (IEAP);
- Biological Synthetic Index (BSI);
- Dehydrogenase Activity (DA).

Degradation of soil resources represents a complex process that occurs in time. There is a partial or total loss of the productive capacity of the soil in terms of quantity and quality.

Soil degradation is the loss of actual or potential productivity or utility as a result of natural or anthropogenic factors. Soil degradation is a global threat and it has a very strong impact on food, energy resources and environments, especially regarding to water quality and greenhouse effect (Lal, 1999). The vicious cycle of soil erosion → low crop yields → poverty and malnutrition → low resource agriculture → more severe soil erosion and degradation must be broken by technological and policy interventions (Lal, 1999, Figure 2).

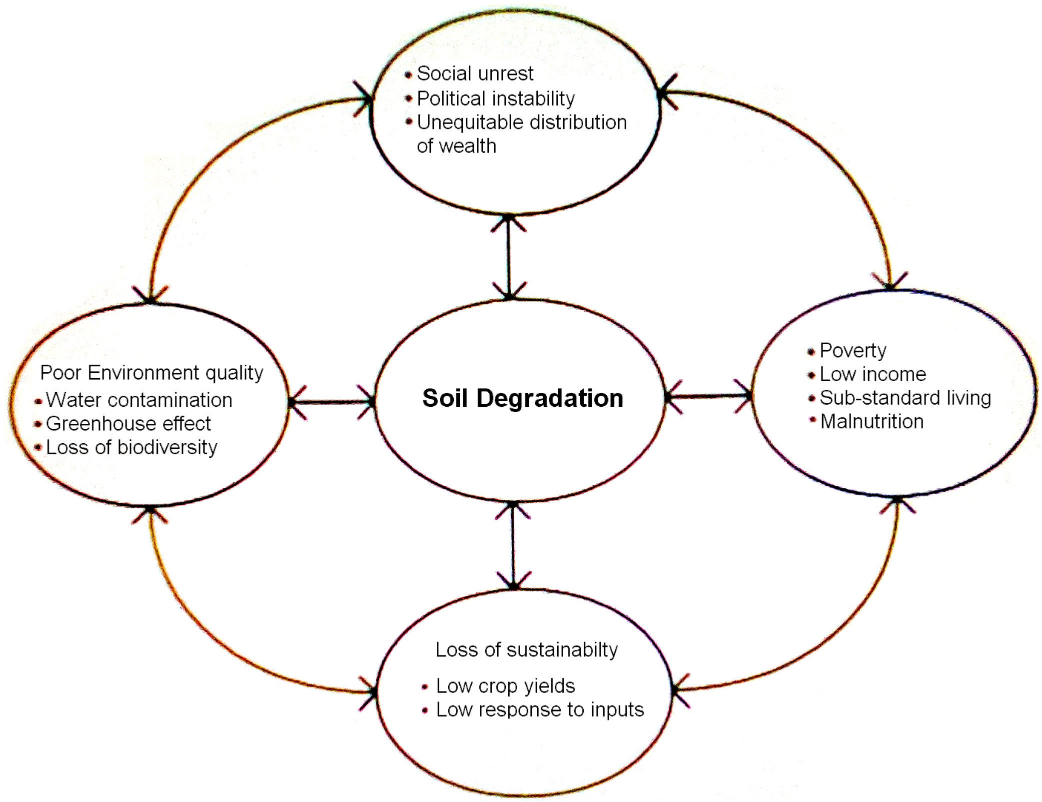


Figure 2. The vicious cycle of soil erosion (after Lal, 1999)

There is a strong connection between soil degradation, environmental quality, food security and energy use.

As soil degradation effects we can mention soil erosion (as a result of the various types of degradation), soil compaction and de-structuring, severe reduction (below 10%) of forest areas, salinization, depletion of soil organic matter (SOM) and nutrients.

Soil fertility is a complex process that involves the constant cycling of nutrients between organic and inorganic forms. As plant material and animal wastes decompose they release nutrients to the soil solution. Those nutrients may then undergo further transformations which may be aided or enabled by soil micro-organisms. Natural processes such as lightning strikes may fix atmospheric nitrogen by converting it to NO_2. Denitrification may occur under anaerobic conditions (flooding) in the presence of denitrifying bacteria.

We can consider that soil fertility is a biological feature that, together with physical and chemical soil features determines the soil quality (Scherr Sara, 1999, International Food Policy Research Institute, USA-IFPRI).

Soil quality is the capacity of a specific type of soil to function, within natural or managed ecosystem conditions, to sustain plant and animal productivity, maintain or enhance water and air quality, and support human health and habitation (Johnson D.L. *et al*., 1997). Soil quality reflects how well a soil performs the functions of maintaining biodiversity and productivity, partitioning water and solute flow, filtering and buffering, nutrient cycling, and providing support for plants and other structures. Soil management has a major impact on soil quality.

Sustainable soil-use refers to "the use of soil as a natural resource on a way that does not exert any negative effects - that are irreparable under rational conditions - either on the soil itself or any other systems of the environment" (after Tóth et al., 2007). The sustainability of soil-use can be achieved by the practical methods of management and can only be guaranteed if the material and energy flow associated with soil processes are controlled and positively influenced. This means the management and maintenance of certain level of soil characteristics, which eventually embrace soil quality as well.

Long-term influence of human impact (by land use change; amelioration/restoration measures; degradation effects) on the ecological conditions of soil as well as the seasonal soil-use operations (drainage, cultivation, irrigation, nutrient management etc.) modify material and energy flows, resulting in the transformation of the pedogenic processes at smaller or greater extent. When these processes are traceable, controllable, soil-use and soil quality remains sustainable in the long run (Tóth *et al.,* 2007).

Other authors (Cousins, 2001; Lopez *et al*., 2001, Dazzi *et al*., 2008) highlighted that, the anthropogenic impact on vegetation cover, or the intensive agricultural practices in large scale farming can cause major canges to the environment. The modification to the soil scape can lead to an increase in soil aggregate breakdown, loss of organic matter, an increase of soil erosion and, eventually desertification (Brandt *and* Thornes, 1996; Drake *and* Vafeidis, 2004; Dazzi *et al*., 2008). So, the attention must be focused on the relationship between land use/land cover changes and land degradation due to anthropogenic soils (Dazzi *et al.,* 2004, 2008).

Change over time in these characteristics represents „DEGRADATION or IMPROVEMENT”.

Degradation process include (Lal and Stewart, 1990): erosion, compaction and hard setting, acidification, declinining soil organic matter, soil fertility depletion, soil pollution, biological degradation.

Quality can vary across sites, production systems, and soil types. Soil quality in the inherent capability of the soil to perform a range of productive, environmental and habitat functions.

Diverse definitions of productivity have created some confusion (Scherr Sara, 1999).

Definition of „Soil productivity” is used to refer to the actual yield of usable vegetation, also controlling for input use.

Definition of „Agricultural productivity” refers to the relationship between the average or real output of economically usable products divided by an index of all fixed and variable inputs.

Soil quality contributes relatively more to agricultural productivity in low-input production system.

Have been identified five main types of anthropogenic impact that can lead to soil degradation (Parichi, 2000, Table 4): overgrazing, deforestation, overexploitation of vegetation, bio-industrial activities and poor land management.

Table 4. The main causes of land degradation worldwide - millions ha (Parichi, 2000)

Continent	**Deforestation**	**Overgrazing**	**Poor management**	**Overexploitation of vegetation**	**Bio-industrial activities**
Africa	67	**243**	121	**63**	+
Asia	**298**	197	**204**	46	1
South America	100	68	64	12	-
Central and North America	18	38	91	11	+
Europe	84	50	64	1	**21**
Australia	12	83	8	1	+
Worldwide	579	679	558	153	22

The Global Assessment of Soil Degradation (GLASOD) based on a formed survey of regional experty, was the first worldwide comparative analysis to focus specifically on soil degradation (Oldeman, 1994; Scherr Sara, 1999).

GLASOD estimates of the extent and severity of degradation from world to 1990. This study concluded that 1,97 billion hectares (23% of globally used land) had been degraded (Table 5): 9% of all cropland, pasture and woodlands was lightly degraded in 1990; 10% was moderately degraded, implying a large decline in productivity, and 4% was strongly degraded, implying a virtual loss in productive potential.

Table 5. Global estimates of soil degradation, by region and land use (million hectares) (Oldeman, 1994; Scherr Sara, 1999)

Region	**Agricultural land**			**Permanent Pasture**			**Forests and Woodland**			**All used land**				
	Total	**Degraded**	**%**	**Total**	**Degraded**	**%**	**Total**	**Degraded**	**%**	**Total**	**Degraded**	**%**	**Seriously degraded**	**%**
Africa	187	121	65	793	243	31	683	130	19	1663	494	30	321	19
Asia	536	206	38	978	197	20	1273	344	27	2787	747	27	453	16
South America	142	64	45	478	68	14	896	112	13	1516	244	16	139	9
Central America	38	28	74	94	10	11	66	25	38	198	63	32	61	31
North America	236	63	26	274	29	11	621	4	1	1131	96	9	79	7
Europe	287	72	25	156	54	35	353	92	26	796	218	27	158	20
Oceania	49	8	16	439	84	19	156	12	8	644	104	17	6	1
World	1475	562	**38**	3212	685	**21**	4048	719	**18**	8735	1966	**23**	1216	**14**

Water erosion caused the most degradation, followed by wind erosion, soil nutrient depletion, and salinization (Tables 6 and 7).

Table 6. Global extent of chemical and physical soil degradation, by region (million ha)

Region	**Chemically degraded area**				**Physically degraded area**			**Total degraded Land**	**Total degraded land as % of total used**
	Loss of nutrients	**Salinization**	**Pollution**	**Acidification**	**Compactation, sealing and crusting**	**Water logging**	**Loss of organic matter**		
Africa	45	15	+	1	18	1	-	81	4,8
Asia	15	53	2	4	10	+	2	86	3,0
South America	68	2	-	+	4	4	-	78	5,1
Central America	4	2	+	-	+	5	-	12	6,0
North	-	+	+	+	1	-	-	1	+

America									
Europe	3	4	19	+	33	1	2	62	7,7
Australia	+	1	-	-	2	-	-	3	-
World	136	77	21	6	68	11	4	323	3,7

Source: Oldeman, Hakkeling and Sombroek, 1991; Scherr Sara, 1999.

Table 7. Global extent of soil degradation due to erosion, by region (million ha)

Region	Area eroded by water erosion				Area eroded by wind erosion				Total area eroded	Total area seriously Eroded	Total area seriously eroded as a % of total land used
	Light	Moderate	Strong and extreme	Total	Light	Moderate	Strong and extreme	Total			
Africa	58	67	102	227	88	89	9	186	413	267	16
Asia	124	242	73	441	132	75	15	222	663	405	15
South America	46	65	12	123	26	16	…	42	165	93	6
Central America	1	22	23	46	246	4	1	5	51	50	25
North America	14	46	…	60	3	31	1	35	95	78	7
Europe	21	81	12	114	3	38	1	42	156	132	17
Oceania	79	3	222	83	16	…	27	16	99	3	3
World	343	526	223	1094	269	254	26	548	1642	1029	12

Source: Oldeman, Hakkeling and Sombroek, 1991, Scherr Sara, 1999

2
Strategies for protection and conservation of soil resources in EU

At 22. 09. 2006 the European Commission adopted:

- COMMUNICATION COM (2006) 231;
- DIRECTIVE COM (2006) 232;
- IMPACT ASSESSMENT SEC (2006) 620.

In the COMMUNICATION **COM (2006) 231, Thematic Strategy for Soil Protection** stating the following**:**

► An estimation of 115 million hectares or 12% of Europe's total land area are subject to ***water erosion*** (Figure 3), and 42 million hectares are affected by ***wind erosion*** (Figure 4);

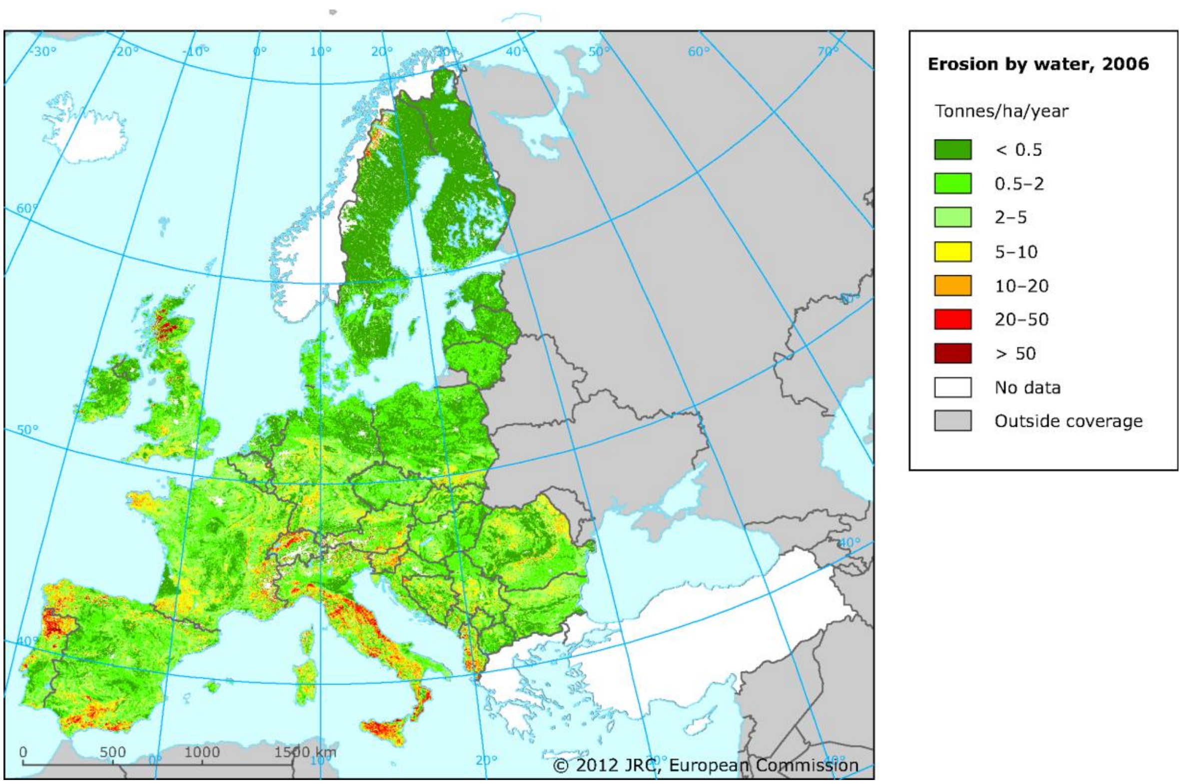


Figure 3. Erosion by water in Europe, 2006
(JRC, European Commission)

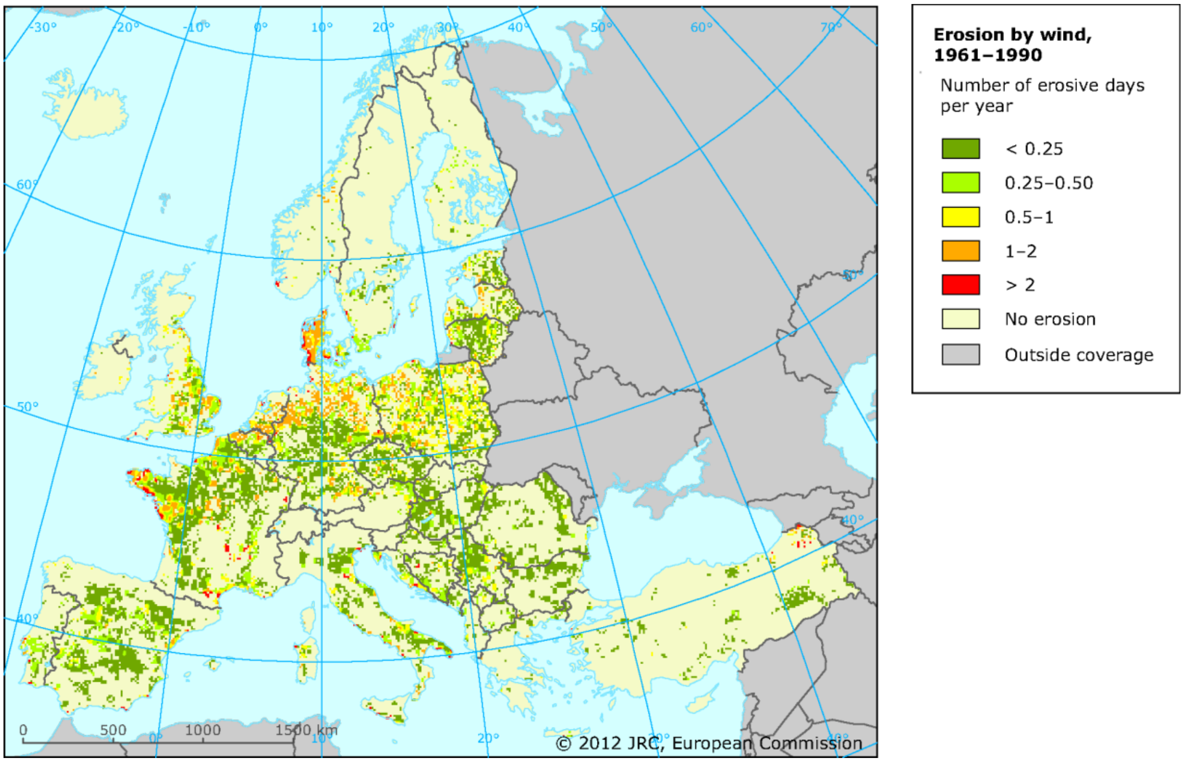


Figure 4. Erosion by wind in Europe, between 1961-1990
(JRC, European Commission)

► An estimation of 45% of European soils have ***low organic matter***, particularly in the Southern of Europe, but also in areas of France, the UK and Germany;

► The number of ***potentially contaminated sites*** in EU-25 is estimated at approximately 3.5 million;

► Between 1990 - 2000 year period, at least 2.8% of Europes land was subject to a change in use, including significant increase in urban areas (***soil sealing***);

Framework Programme 7 (FP 7) Strategy for action Soil follows the next directions:

• ***Establish the European Soil Data Centre (ESDAC)*** as a single focal point for all soil data information in Europe;

• ***Develop procedures and method for data collection, Quality Assurance/Quality Control (QA/QC), data management and storage, data distribution*** to Commission and external users, fully complying with INSPIR principales for spatial data infrastructures;

● Research and development of ***advanced modelling techniques indicators and scenario analyses*** in relation to the major threats to soil (erosion, decline of organic matter, compaction, salinisation and landslides);

● Extension of the coverage of the ***European Soils Information System (EUSIS)*** towards of a fully operational ***Global Soil Information System (GLOSIS)***, providing relevant soil information for the implementation of multilateral environmental agreements like **United Nations Framework Convention on Climate Change (UNFCCC)**, United Nations **Convention on Biological Diversity (CBD)** and contributing to the ground segment of **Global Monitoring for Environment and Security (GMES).**

Overal objectives:

► **Preventing** further *soil degradation and preserving its functions*:

● when soil is used and its functions are exploited action has to be taken on soil use and management patterns and

● when soil acts as a sink/receptor of the effects of human activities or environmental phenomena action has to be taken at source.

► **Restoring** soils to a level of functionality consistent at least with current and intented use thus also considering the cost implications of the restoration of soil**.**

Action and Means

■ **Framework legislation** with protection and sustainable use of soil as its principal aim.

■ **Integration** of soil protection in the formulation and implementation of national an Community policies.

■ **Research** supported by Community and national research programes. Public awareness of the need protect soil.

RESEARCH PRIORITY: ***DEVELOPING A NEW SOIL QUALITY INDICATOR*** for the EU taking into account the multi-functionality of soils as defined in the Soil Thematic Strategy (Source: Toth G., Stolbovoi V. and Montanarella L., 2007, *Institute For Environmental, Ispra, Italy).*

After Gunther *et al.*, (2011) in: EU-wide landslide susceptibility assessment in the context of the Thematic Strategy on soil presented at the Symposium: EU-level Landslide susceptibility assessment of landslide of International Institute for Geo-Information Science and Earth Observation (ITC) Enschede, The Netherlands, 4-5.07.2011 to the attention of the strategy I am following ***THEMATIC OBJECTIVES AND SOIL THREATS:***

Objectives:

► *SOIL PROTECTION* against degradation.

► *PRESERVATION OF SOIL CAPACITY* TO DEVELOP ITS FUNCTIONS: ECOLOGICAL, ECONOMIC, SOCIAL AND CULTURAL.

SOIL THREATS:

- *erosion*
- *organic matter decline*
- *contamination*
- *salinisation*
- *compaction*
- *soil biodiversity loss*
- *landslides*
- *flooding.*

All these threats, not being taken into account, or incomplete considerated, will lead to distruction of soil structure.

Developing countries face serious environmental problems at local or natural level, having no possibilities, especially materials ones help solve the global issues (Negruţ *and* Miculescu, 2009).

Minimum requirements for achieving sustainable development are:

-re-size the economical increase, given a more equitable distribution of resources and increased quality of the production;

-ensuring an acceptable level of population increase (control of population increase);

-elimination of poverty by leeting the basic needs for jobs, food, energy, water, housing and health;

-preserve and enhance natural resources, maintenance of ecosystem diversity, monitoring environmental impacts of economic activity;

-shift technologies and control the risk;

-government descentralization, increasing participation of local authorities in decision making;

-corroboration decisions on environment and development of local level to those in the international area.

Global Land Degradation (GLASOD) is pivotal to the United Nations Convention to Combat Desertification, the Convention on Biodiversity, and the Kyoto Protocol on Global Climatic Change. International Soil Reference and Information Centre - United Nations Environment Programme (ISRIC-UNEP) Project for a Global Assessment of Human–Induced Soil Degradation (GLASOD) in collaboration with many institutions and individual experts worldwide from Global Soil Degradation Map realized qualitative criteria from Guidelines for General Assessment of Human–Induced Soil Degradation (Table 8).

Table 8. Human-Induced Soil Degradation in the World (million hectares)
(Oldeman, 1988; van Lynden, 2004)

Type	Light	Moderate	Strong	Extreme	Total
Wt Loss of topsoil	301.2	454.5	161.2	3.8	929.3
Wd Terrain deformation	42.0	72.2	56.0	2.8	173.3
W Water	343.2	526.7	217.2	6.6	1093.7 (55.6%)
Et Loss of topsoil	230.5	213.5	9.4	0.9	454.2
Ed Terrain deformation	38.1	30.0	14.4	-	82.5
Eo Overblowing	-	10.1	0.5	1.0	11.6
E Wind	268.6	253.6	24.3	1.9	548.3
Cn Loss of topsoil	52.4	63.1	19.8	-	135.3
Cs Salinisation	34.8	20.4	20.3	0.8	76.3
Cp - Pollution	4.1	17.1	0.5	-	21.8
Ca Acidification	1.7	2.7	1.3	-	5.7
C - Chemical	93.0	103.3	41.9	0.8	239.1 (12.2%)
Pc-Compaction	34.8	22.1	11.3	-	68.2
Pw Waterlogging	6.0	3.7	0.8	-	10.5
Ps Subsidence organic soils	3.4	1.0	0.2	-	4.6
P - Physical	44.2	26.8	12.3	-	83.3 (4.2%)
TOTAL	749.0 (38.1%)	910.5 (46.4%)	295.7 (15.1%)	9.3 (0.5%)	1964.4 (100%)

3
Strategies for protection and conservation of soil resources in Romania

The main limitations of quality of agricultural soils in Romania are presented in table 9.

Table 9. The main limitations of quality of soil resources in Romania
(after Dumitru *et al.*, 2004)

Name of limiting factor	**Affected area – thousands ha**	
	Total	**Arable**
Frequent drought	**7100**	
Irrigation facilities	3211	
Periodically moisture surplus in the soil	3281	
Drainage facilities	3196	
Soil erosion by water	**6300**	**2100**
Anti-erosion works	2274	
Landslides	702	
Soil erosion by wind	378	273
Excessive frame surface	300	52
soil salinization	614	
High alkalinity	223	135
Soil compaction by improper work (plow sole)	**6500**	**6500**
Primary compaction of the soil	2060	2060
Crust formation	2300	2300
Low/very low humus reserve	7485	4525
Strong and moderate acidity	3424	1867
Low and very low mobile Phosphorus supply	6330	3401
Low and very low mobile Potassium supply	787	312
Low Nitrogen supply	5110	3061
Deficiencies of micronutrients (zinc)	1500	1500
Chemical soil pollution, of which:	900	
- excessively polluted	200	
- oil pollution and salt water	50	
- pollution by substances carried by the wind	147	
Soil damaged by excavation	15	
Waste land coverage	18	

These restrictions and limitations of the potential food background are based on environmental factors (relief, climate, edaphic background) or anthropogenic factors (agricultural or industrial), or a result of synergistic action of several negative factors (Dumitru *et al.*, 2001; Dumitru *et al.*, 2004).

Frequent drought - Restrictive effects of drought are felt on 7,1 million ha, including the majority of land prepared for irrigation (before 1990). In 2002 was actually irrigated only a few hundred thousand hectares (out of 3.176.283 hectares, according to statistics), most facilities being not functional. Drought is a limiting and negative factor in crop production on the largest areas.

Periodically soil moisture excess exists on 3.8 million ha, most of these areas (3.2 million ha) being in not functional landscaped grounds by drainage works.

Water erosion affects 6.3 million ha, most of the affected areas (2,3 million ha) are located in systems previously designed anti-erosion works heavily degraded (Figure 5).

Landslides - land areas affected by landslides are 702 000 ha (Figure 5).

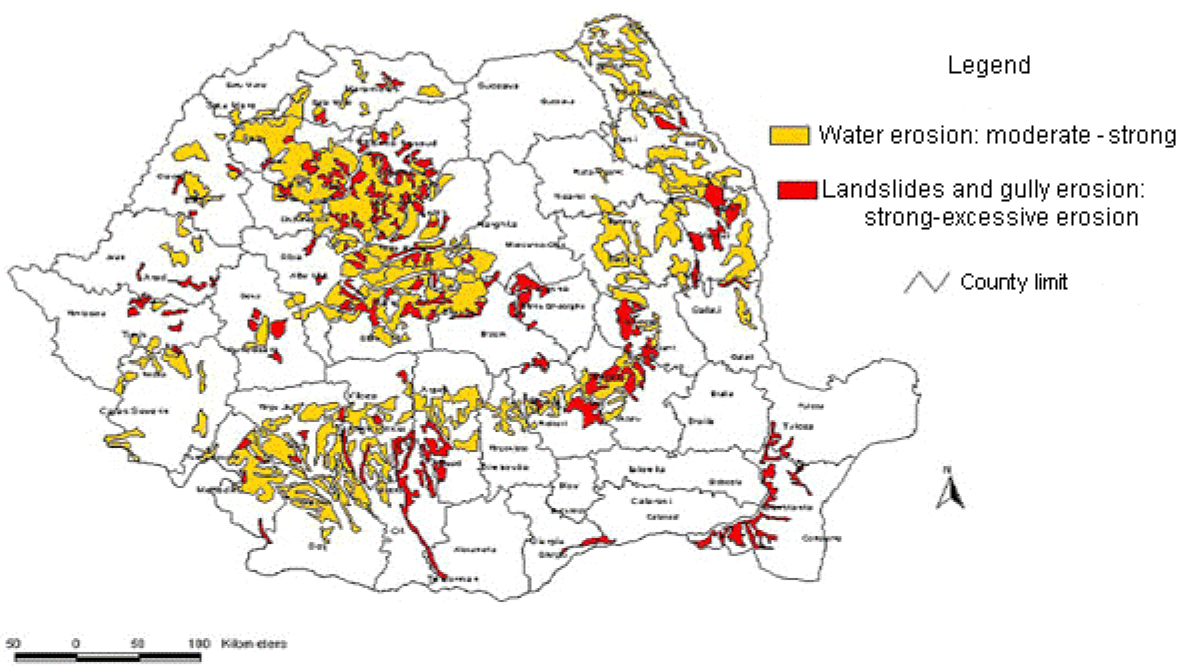


Figure 5 . The map of the Romanian lands affected by water erosion and landslides
(*Source:* Research Institute for Soil Science and Agrochemistry, Bucharest, Romania. National Strategy and Action Programme concerning Desertification, Land Degradation and Drought, Prevent and Control, 27 November, 2001)

Waste land coverage - are around 300 000 ha.

Soil salinization - areas affected by salinization exceed 600 000 hectares, with increasing trends in irrigation and drainage facilities used rationally and in areas with potential secondary salinization (about 0,6 million ha).

Destruction of soil structure, compaction and crust formation – crust formation tendency manifests on 2,3 million ha. Primary compaction is present on 2,0 million ha and soil compaction by improper work (plow sole) occurs on 6,5 million ha.

Improper agrochemical status - small reserves of humus affects 7,5 million ha. Moderate and strong acidity affects 3,4 million ha. On 6,3 million ha there is a low content of available phosphorus, on 0,8 million ha there is a poor and very poor mobile insurance potassium, on 5,1 million ha there is a low nitrogen content, 1,5 million ha are affected by zinc deficiency.

Wind erosion - affects about 378 000 ha, but there is danger because of deforestation and expansion of protective cutting in areas susceptible to this type of degradation.

Soil pollution - about 0,9 million ha, of which excessive pollution on about 0,2 million ha and 50 000 ha polluted with oil and salt water.

Soil damaged by excavation - an area of 15 000 ha, mainly due to mining excavations.

Coverings with solid waste - by covering the soil with various solid waste were set aside about 18 000 ha.

In 1997, Romania signed the Convention to Combat Desertification, by Law no. 629/1997 and organized the Romanian National Desertification Committee, which drafted the National Strategy and the Action Program to Combat Desertification, Land Degradation and Drought and elaborated the National Plan to Combat Desertification in Romania.

In Romania, desertification can be a major threat for 30% of the country, in the south and southeast and the Western Plain, where aridity index (R) is equal or less than 0,65. There are not desertified areas in Romania, of significant size (only small areas with rocky, thin soils and highly eroded soils in Dobrogea) and therefore we can not talk about the actual occurrence of desertification but the green areas at risk of desertification. Under the conditions of definitions accepted by UNCCD and transposed into national law by Law 111/1998, preventing and combating desertification consists of actions and measures taken to curb soil degradation processes mentioned above, under arid climate, semiarid and subhumid-dry (Figure 6).

Figure 6. Total erosion on the agricultural land in Romania – tons/ha/year
(after Motoc M., 1983)

The main measures to prevent these effects are the changes to the structure of crops (and varieties), their adaptation to new climatic conditions and cultural expansion of specific technologies such climates.

Area subjected to desertification, climate characterized by arid-semiarid or subhumid land is approximately 30% of the total area of Romania, being generally located in Dobrogea, Southern Romanian Plain and Tisa West Plains. This area is used mainly in agriculture (about 80% of the total, of which approximately 60% are arable land), forestry (about 8%) and water, especially Danube Floodplain and Delta. In Romania, the main anthropogenic and environmental factors that may induce the risk of desertification are:

a) **Ecological** factors and determinants:

- progressive desertification climate, amid global climate change (the last 100 years there has been a progressive aridity of the climate, especially in the South and South East, due to warming and reduced precipitation);

- erosion caused by the torrential rainfall in dry and sub-humid areas;

- increased frequency and intensity of droughts (in the last 100 years were 3 dry and extremely dry long periods: 1894 to 1905, 1942-1953 and 1992-2000);

- large land areas with slopes of more than 5% of Dobrogea and Southern Moldova, presents favorable conditions for erosion and increased runoff;

- drought vulnerability of different soil types: sandy or loamy soils, eroded soils or salinised soils.

b) **Anthropogenic** factors: overgrazing (figure 7), chemical pollution.

Figure 7. Example of pasture degraded by overgrazing in Tutova Hills

3.1. Main measures and actions to prevent and combat desertification

The National Strategy and Action Programme to Combat Drought and Desertification provided a set of complex measures, among which the most important ones:

1. Scenarios to determine the areas of the phenomenon of drought (drought forecasting the effect of changes in groundwater level by using a medium or long term forecasting hydro-geological program, in order to achieve some programs use surface water, groundwater and deep underground);

2. Protection of the environment (protection of water resources quality, reduce greenhouse gas emissions in air pollution prevention, reduce chemical treatments on soil, control drought and desertification;

3. Rehabilitation and development of irrigation systems (about 3,2 million ha) by:

- increasing global efficiency (transport, distribution pumping stations and watering the field) and economic efficiency;

- promoting and encouraging irrigation under a wide range of types of farm management,

- using of local network automation schemes irrigation channels to reduce the lost water and to limit the impact of irrigation on the environment;

- recovery, rehabilitation and modernization of irrigation use, on all suitable areas.

4. Creating curtains and forest shields include:

- developing, in agricultural areas, of principal and secondary forest belts, to protect the field (as modules 300, 500, 1000 ha of agricultural land, accounting for 2-5% of the surface);

- developing the protective forest shields along highways, roads and railways;

- developing the protective forest irrigation channels, water reservoirs, watercourses;

- developing the rectangular forest belts;

- rehabilitation of pastures in arid zones by carrying bouquets of trees to protect animals from heat and making drinking water tanks.

5. Enhancing the hydrological regime of rivers dammed areas;

6. Sloping terraces on the slopes for water retention and reduce surface leakage through various works such as terraces with opposed platform, in steppe and forest steppe regions and planting pits equipped with hoppers, or wave plates and ditches;

7. Using the alternative crops, resistant to drought and implementation of special agricultural measures.

Data collected until now, by soil monitoring and other studies (Dumitru M. et al., 2001; Dumitru M. *et al*., 2004; Hurjui C. *et al*., 2008; Ioniţă I., 2007) has allowed and will allow the recommendations for rehabilitation, renaturation or if necessary, reconstruction of some green areas affected by degradation processes in the context of sustainable development and prevention and combating excessive and frequent drought and desertification risk.

3. 2. Control measures and types of erosion in Romania

Romania presents the most various forms created by water erosion due to its natural conditions. According to the *National Strategy and Action Programme to Combat Desertification, Land Degradation and Drought,* developed by the Institute for Soil Science and Agrochemistry in

Bucharest (2001) and following the *National Strategic Plan of Romania* for the 2007-2013 period, developed by Ministry of Agriculture, Forests and Rural Development in June 2006, it becomes evident that almost one third of the country is affected by various forms of soil degrsdation. The most important factors are the pluvial erosion and landslides, which affect about 7 millions hectares. The soil organic matter (SOM) loss caused by the removal of the topsoil ranges between 45% and 90% of the total organic matter pool in the soil. At the country level, the total SOM losses amount are estimated at approximately 0.5 million tones/year. The areas with the highest rates of soil erosion are: Moldavian Plateau, in which is included the investigated area Tutova Hills, Pericarpathian Hills between Trotuş and Olt, Transylvanian Plateau and Getic Piedmont.

Wind erosion is present in restricted areas, especially in the South of the country. The most critical period of erosion processes which is may-august when torrential rains occur frequently, especially slopes, more than 5% and shall occupy 42,6% of the total (Table 12).

Man`s activity had an important role in inducing and intensifying of the erosion processes, particularly by the land-use, crops structure on the arable land, crop farming, management of pastures and forests. Forest are concentrated mostly on mountain area (Parichi, 2000; Nistor *et al.*, 2004).

Table 10 illustrates that among agricultural lands most of the pastures (grazingland) and the vineyards are laying out on sloping lands, especially with erosion potential.

Table 10. Use of the sloping lands with erosion potential
(Parichi, 2000; Nistor *et al.*, 2004)

Land use	**Areas**		**Mean slope value** %
	Over 5% slope (mil. ha)	**Percentage from total land**	
Agricultural, from which:	6.367	42.6	18,2
Arable (Cropland)	2.572	26,0	17,0
Pastureland	3.360	75,0	21,8
Wine plantations	0.169	55,0	16,0
Fruit plantations	0.266	75,0	18,0
Forestland	5.748	87,5	40,4

All the arable land is located on ”gentler“ slopes. This is a major source for soil losses because the high ratio of the row crops, as sunflower, potatoes, corn, dry beans, has influenced a high rate of the erosion processes. The non-adequate management of the pastures had also an unfavourable influence.

The surfaces affected by erosion, that include the agricultural lands, forests and the unproductive areas on slopes, are reported in table 11.

Of the 7380 million ha degraded by erosion, about 3,4 million has a poor erosion and the difference of about 3,9 million hectares are affected by moderate to strong erosion (about 3,0 million ha eroded by water, about 0,7 million hectares of landslides and wind erosion about 0,2 million ha (Hurjui *et al.*, 2008).

Table 11. Distribution of the eroded surfaces on erosion levels
(Nistor *et al.*, 2004, 2010)

Class of erosion	**Land eroded**	
	Millions ha	**%**
Slight erosion	3.420	46.3
Moderate and high erosion	3.060	41.5
Severe and excessive erosion	0.900	12.2
Total	**7.380**	**100.0**

Shifting attention now toward the agricultural eroded lands only (Nistor *et al.*, 2010) it has been found that the slight-severe erosion classes average about 43% of the entire area (non-appreciable -57,4% -Table 12).

Table 12. Agricultural eroded land by the erosion rate (Nistor *et al.*, 2004, 2010)

Class of the erosion intensity	Variation limits of value the erosion intensity (t/ha/year)	Mean (t/ha/year)	Percentage from the agricultural lands area (%)
Non-appreciable erosion	<1	0,5	57,4
Slight erosion	2-8	5,0	3,0
Moderate erosion	8-16	12,0	19,0
High erosion	16-30	23,0	18,0
Severe erosion	30-45	37,5	2,6

The peak erosion rate is recorded in the Subcarpathians Curvature: 30-45 t/ha/year.

Then follow with high values: 20-30 t/ha/year, the Meridional Subcarpathians, the Getic plateau, the Moldavian plateau, and the Western part of Transylvanian plateau.

About the classes of erosion intensity, it is noticed that are predominating the classes with moderate–high rate: 9-30 t/ha/year.

A special attention was given to the sediment sources by contributions of the major land-uses or of the classical erosion types to the making up of the total erosion (Tables 13 and 14).

Table 13 reflect different input levels to the gross erosion making up (Nistor *et al.*, 2010).

Table 13. Total erosion by land-uses (Nistor *et al.*, 2010)

Land use	**Total erosion**			
	Million t/year	**%**		
Cropland (Arable land)	28.0	26.2	24.7	22.3
Pasture (Grazing land)	**45.0**	47.2	39.6	35.7
Vineyards	1.7	1.6	1.5	1.2
Orchards	2.1	2.0	1.8	1.7
Unproductive (Abandoned land as gullies)	29.8	28.8	26.4	23.6
Agricultural land total	**106,6**	**100**	**-**	**-**
Woodland-total	**6.7**	**-**	**6.0**	**5.3**
Total	**113.3**	**-**	**100.0**	**-**
Bankrivers and Localities erosion	12.7	-	-	10.2
General total	**126.0**	**-**	**-**	**100.0**

In terms of the physical soil losses from agricultural land, estimates run as high as 106,6 million tons/year. Of this amount, an estimated 102,8 million tons/year represents the total erosion making from grazingland, unproductive land and cropland.

The greatest amount of solid material eroded resulting from land occupied by pastures (45,0 million t/year), then the unproductive lands (29,8 million t/year) and arable land (28,0 milllion t/year).

In the table 16 is noted that surface (sheet and rill) and gully erosion are that most important contributing types of erosion.

Among the effects of soil erosion for agriculture, losses of cropland are very important**.**

Table 14. Total erosion by types of water erosion (Nistor *et al.*, 2010)

Type of erosion	Total erosion		
	Millions t/year	**%**	
Surface erosion	61.8	54.5	49.0
Gully erosion	29.8	26.4	23.6
Landslides	15.0	13.1	11.9
Gully erosion and landslides on woodland	6.7	6.0	5.3
Total	113.3	100.0	-
Bankrivers and Localities erosion	12.7	-	10.2
Total	**126.0**	**-**	**100.0**

Landslides, gully erosion (figure 8) and surface erosion represents the causes for the decreasing of cropland acreage. It is difficult to estimate these losses by landslides because it was not yet elaborated a prediction method for starting (inducing) of such a process (Nistor *et al.*, 2004).

Figure 8. Example of gully erosion in Tutova Hills

If are considered the events over the last decades, it is possible to estimate that in Romania, during a landslides cycle, which might be repeted once in 30 years, an area of 80 000 ha was affected, that means an annual rate of 2700 ha.

For gully erosion an estimate is more precisely, because it was established that gullies provide an annual loss up to 30 million tons of sediments or 23 million cubic meters if a bulk density of 1,2 g/cmc is taking into account.

In terms of the type of erosion, the erosion surface represents 34% from the amount of eroded land, then the erosion in depth with 26,4% and then landslides with only 13,1%.

3. 3. Environmental features of the Tutova Hills

The Bârlad plateau occupies approximately 11000 square kilometers of Eastern Romania and it covers the Central-Southern part of the Moldavian Tableland is drained mostly by the hydrografic basin of the Bârlad river.

The climate is temperate continental with an annual average temperature of 8-9,8^0 C, and annual average rainfall of 450-600 mm.

It is generally underlined the outstanding the various conditions of the Bârlad Tableland, like lithological, geomorphological, climatical, pedological as well human activity to the development the present–day geomorphological processes among which the landslides are very impressive.

1. The northern part of Central Moldavian plateau (further side of the line that would link the villages Bozieni and Ciorteşti) is characterised by old landslides specially. A mention must be made for its higher rate of forestry cover.

2. **The southern part** of the Central Moldavian plateau is ranging between the Bozieni-Negreşti-Ciorteşti line and Racova-Lohan Creeks. There are occuring a lot of active landslides by moderate thickness typically.

3. High Hills of Tutova that is lying between Racova Creek and the conventional line Dealu-Morii-Puieşti-Târzii. There are best conditions, like the combination of sandy and clayey deposits, energy, severe gullying and forest clearing, for stopping the numerous slides of great thickness slides.

4. **Rather South.** There are Low Rolling Hills of Tutova, usually associated with more isolated landslides, because prevailing sandy layers, gulling representing here the major process of land degradation.

The most affected area by sliding processes is comprised between the following conventional lines: Bozieni-Ciorteşti at North and Dealu Morii-Târzii in South. This area is by far well-known for its very high intensity of land degradation on Romanian sloping cropland.

This circumstances called for better soil and water conservation in the Bârlad plateau and consequently in 1956, Perieni, a locality on the Tutova Hills, was selected as site of the **Central Research Station for Soil Erosion Control on Cropland from Romania.**

The **erosion rates by crops** highlights that long time field measurements, conducted at a Perieni Research Station of Moldavian plateau on standard runoff plots with loamy-textured soils (Chernozems, Phaeozems – WRB, 2006) illustrate the influence of crops on soil losses, as reported in table 15 (Ioniţă *et al.*, 1985 and Popa, 1984).

Table 15. Average annual soil losses at Perieni Station between 1958-1984 (Nistor, 2002)

Crop	Soil loss-t/ha/year
Corn	17,9
Peas	4,1
Winter wheat	2,2
Brome grass	0,3

In terms of **yields of crops**, one of the most important damage caused by surface erosion is the steady decline of crop fields. Research conducted in Romania has shown a stratification of yields on crops depending upon the thickness of eroded soil. It has been found a rapid increase of crop losses particularly when erosion affect bioaccumulation horizon or tranzition horizons.

Thus for one cm depth of eroded soil, an amount of 60 kg grains is lost if is considered an average yield of 4000 kg/ha for non-eroded soils.

For a short time, these losses are large, but on long term they become very high because the crop losses from the previous years are included.

Experiments conducted at Perieni Station Research (Nistor, 2004) on moderate eroded soils have illustrated that, there is no a significant difference on corn yield between the main basic tillage (Table 16).

Table 16. The influence of the different tillage on corn yield (Nistor, 2004)

Tillage	Average corn yield					
	1974-1977			1992-1995		
	q/ha	%	Dif.q/ha	q/ha	%	Dif.q/ha
Plowing	62,7	100	-	40,3	100	-
Chisel	62,7	99,8	-0,1	41,8	103,7	+1,5
No -till	60,6	96,7	-2,1	39,8	98,7	-0,5

Shifting analysis toward crop yields over the time, in a watershed are underlining a remarkable increase of yield levels after implementing the conservation measures (Table 17).

Table 17. Crop yields in Gheltag watershed from Perieni Station with and without conservation practices (Nistor, 2004)

Crops land Treatment	Yields –kg/ha			
	Before land treatment	After land treatment		
		Strip cropping	Buffer strip cropping	Terraces
Wheat	800-1500	3150-5740	3210-5712	3591-5575
Corn	800-1200	6340-8500	6240-8111350-23254	6112-8014
Peas	400-800			1120-1450

The volume of annual eroded soil was used as indicator related to the active surface unit. The table 18 have shown that the sediment volume is depending on the evolution stage of the gully.

Stationary field experiments are conducted at present in order to ascertain other indicators for estimating the rate of the gully erosion process.

Table 18. Volume of sediments delivered by gullying versus the active unfolded surface (Moţoc *et al.*, 1983 and 2010)

Type of gully	Volume of sediments Cubic meters/ha/year
Ephemeral gully on hillside	50-200
Gullies with evolution by steps,where active reaches alternate with stabilized reaches	200-600
Gullies with rapid evolution without lanfslides or bank sluping	600-1200
Gullies with rapid evolution with landslides or bank sluping	1200-1800

Thus, for one meter average depth of gullies the annual loss of land surface is about 2300 ha. Therefore, landslides together with gullies impair the agricultural lands by 5000 hectares yearly.

The researchers from the Perieni Research Institute conducted researches on the **phenomenological zonation of the study area**. They focused on establishing the optional farming patterns (Pujină *and* Ioniţă, 2004; Nistor *et al.*, 2004) (Figure 9).

Figure 9. Farming pattern at the Perieni Research Institute

Five prediction indicators have been considered such as: morphometric, morphodynamic, geologic-hydrologic, pedologic-mineralogic and agroeconomic.

Considering the classification of land susceptibility to sliding, the variation ranges were divided into four classes of geomorpholodynamical favourability.

Analysis of the present–day intensity of sliding processes, shows that the severe favourability classes, averages 21% of the Bârlad plateau (Table 19).

Sliding processes in the Bârlad plateau have an unperiodical variation on 166 years interval: 1829-1994. The most affected area by landslides the northerly and westerly steep faces and cuestas.

Table 19. Criteria for Phenomenological zonation of the unstable hillslides in the Bârlad plateau (Nistor *et al.*, 2004)

Criterion	Parameters		Class of sliding favorability			
			Severe	**high**	**moderate**	**Low**
	Exposure		**W; NE**	**SW; NW**	**N; E**	**SE; S**
Morphometric	Slope %		15-35	10-30	10-15	5-10
	Length m		800-1600	600-1000	400-800	200-400
Morphodynamic	Frequency of landslides %		16-26	14-15	8-13	2-7
	Actual	Density of landslides ha/km^2	>5	3-5	0.3-3.0	<0.3
	Potential		>30	10-30	5-10	<5

	Lithology	Landslides developed in sandy-clayey layers	Landslides developed in clayey-sandy layers	Landslides developed in a sandy matrix with clay lenses
Geologic and hydrologic	Natural drainage	The cap of the hills is suited for high recharging of water hillslide springs,phreatic streams under pressure or free level	The cap of the hills permits an average recharging of water hillslide springs,phreatic streams under pressure or free level	Temporary springs, perched water table
Pedologic and mineralogic	Soil type	Land with various microrelief,moisture Excesses in luvisols-mollisols area	Land with various microrelief, moisture Excesses in luvisols-mollisols area	Gently broken up land in mollisols area
	Colloidal clay %	>50	40-50	<40
	CaCO3 %	7-9	9-12	12-19
	montmorillonit %	>73	68-73	<68
Agroeconomic	Land management	Forest land	Pasture land and windbreaks under trees	Mostly cropland

3. 4. Method of soil erosion control and land improvement. Types of erosion prevention used until now

Romania is still maintaining the traditional conservation measures on the agricultural fields, such as: contouring (the practice of tillage and planting on the contour), stripcropping, buffer stripcropping, agroterracing on cropland, wine and fruit plantation terraces, gully control structures, perennial grasses in the crop rotation system and artificial revegetation of the denuded field by shrubs and trees.

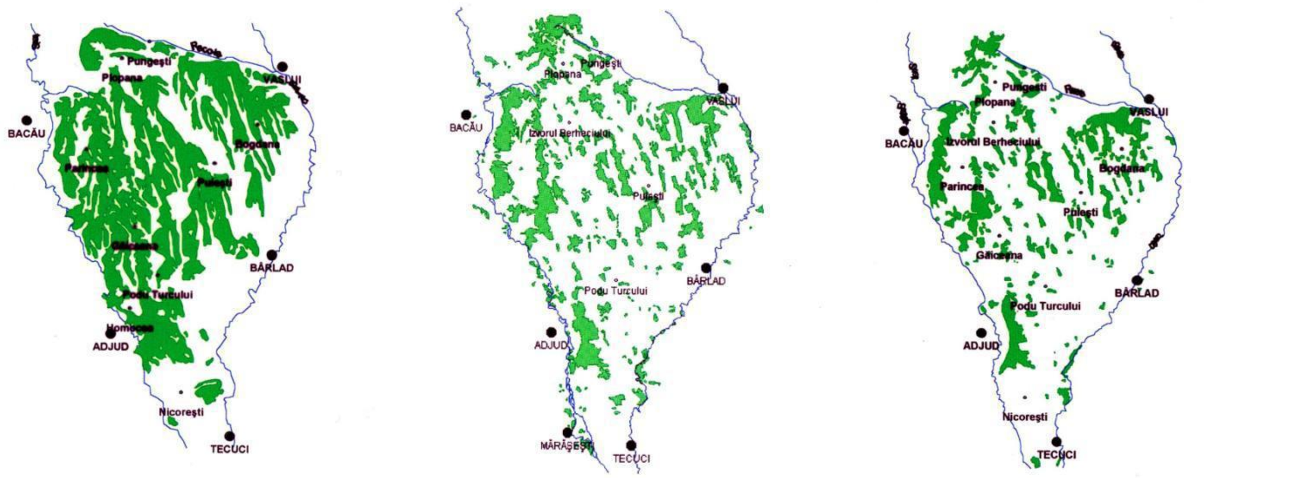
Unfortunately, these methods have been generalized.

Consequently, in some areas were used on large scale, methods that enabled increasing of erosion such as: up-and-down hill plot layout and farming, land clearing for agricultural purposes on hillsides with high risk of erosion.

New methods were implemented besides traditional methods, such as: bench terraces on cropland, terraces by steps constructed with the field broking for wine and fruit plantations, treatment system of fruit plantations by technological alleys, vegetated and mechanical waterways, interception drainage for wet soils on slopes etc.

The total agricultural surface protected by conservation measures is about 2.1 million hectares, that means approximately 30% from the fields with erosion potential.

In Romania there is a big problem with deforestation, especially in Tutova Hills (Figure 10) evidentiating the involution of forest areas in Tutova Hills, between 1832 – 1970 period. In 1832, the forests were on 47,4% of total area of Tutova Hills, decreasing to only 18,8% in 1970.

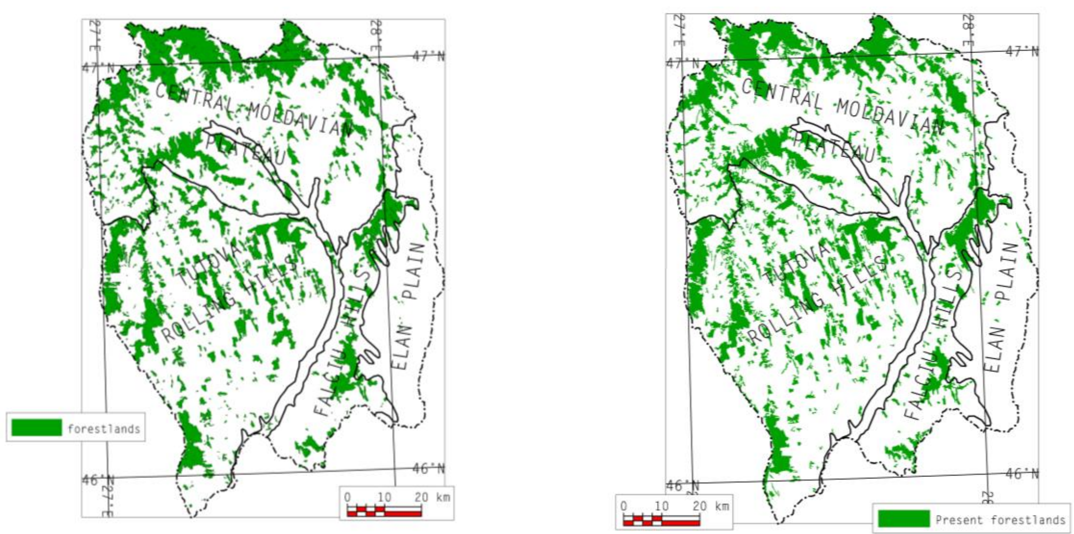


1832 **1893** **1970**

47.4% **21.9%** **18.8%**

Figure 10. Forest distribution in the Tutova Rolling Hills (after Poghirc, 1970)

However, a recent map of the forests of the Moldavian Plateau, including Tutova Hills, shows that the current situation is roughly the same as that of 1893 due to afforestation programs in the last 40 years (Figure 11).



1893 **2013**

Figure 11. Forest distribution in the Moldavian Plateau (after Niacsu, 2013)

4
History of Researches

Since the XIX century, Tutova Hills were the subject of numerous studies regarding geology, geomorphology, pedology, hydrology and climate, but also human geography.

The first ever study regarding the erosional relief of Moldova, with specific reference to the Tutova Hills was made by G. Cobălcescu in 1883. A few years later, Ştefãnescu S. (1897), in his work, *Études sur les terrains de Roumanie*, released some ideas on the non-fossil deposits near Bârlad town, which he called *sarmatian*.

The first researcher who made a direct study on Tutova Hills, was Simionescu I. (1903), referring to the Southern sector of Tutova Hills area called by him “a huge flooding surface” because of the torrents degradation, landslides and channel processes.

In 1908, Sevastos R. published a paper regarding the tectonic ratio between Moldavian Plateau and Romanian Plane, establishing the limits of these two regions.

In his masterpiece called “The Romanian Plain”, Vâlsan G. (1915) treats the problem of the limit between Tutova Hills and The Romanian Plain, issuing the idea of tipping of Tutova Hills that is a very high lifting, being in opposition with the Romanian Plain, which manifests like a strong sinking.

After the World War II, other scientists released more studies to complete the information about Tutova Hills. We consider that Hârjoabă I. made the most complete study on the relief of this area (between 1962-1968).

In the terms of human geography, Poghirc P. (1972) published an important survey called “The Village of Tutova Hills” showing us how the human society influenced the environment.

Very important studies for this area were made by the researchers from the Research and Development Center for Soil Erosion Control – Perieni: Popa A., Luca Al., Moţoc M., Ioniţă I., Popa N. and Hurjui C. Among other studies, they deal with the evolution of the gullies and landslides from Tutova Hills.

In the last years, researchers like Niacsu L. and Stângă I. C. continued the surveys in Tutova Hills with studies on geomorphology, pedo-geography, land use, natural hazards and land vulnerability.

5
The study area

Tutova Hills (Figure 12) are located in the eastern part of Romania, constituting a physical-geographical distinct unit, not only in terms of the natural environment, but also human. As subunit of Bârlad Plateau, this region is delimited to the west and east by the Siret river and wide valleys, respectively Bârlad river. The northern limit is marked by Racova coast and Morii valley (tributary of the Siret), while the south is more rather as an area of interference on the line Mălureni, Nicoresti and Ţepu localities, to the confluence of Berheci river with Bârlad river (Hârjoabă, 1968). Between these limits, Tutova Hills occupies an area of 3603 km^2, extending on the North-South direction, over a maximum distance of approx. 94 km, between 46 º 45'40" N and 45 º 55'10" N, and on the East-West over a maximum distance of approx. 66 km, between 26 º 57'30" E and 27 º 50'00" E (Stângă, 2008).

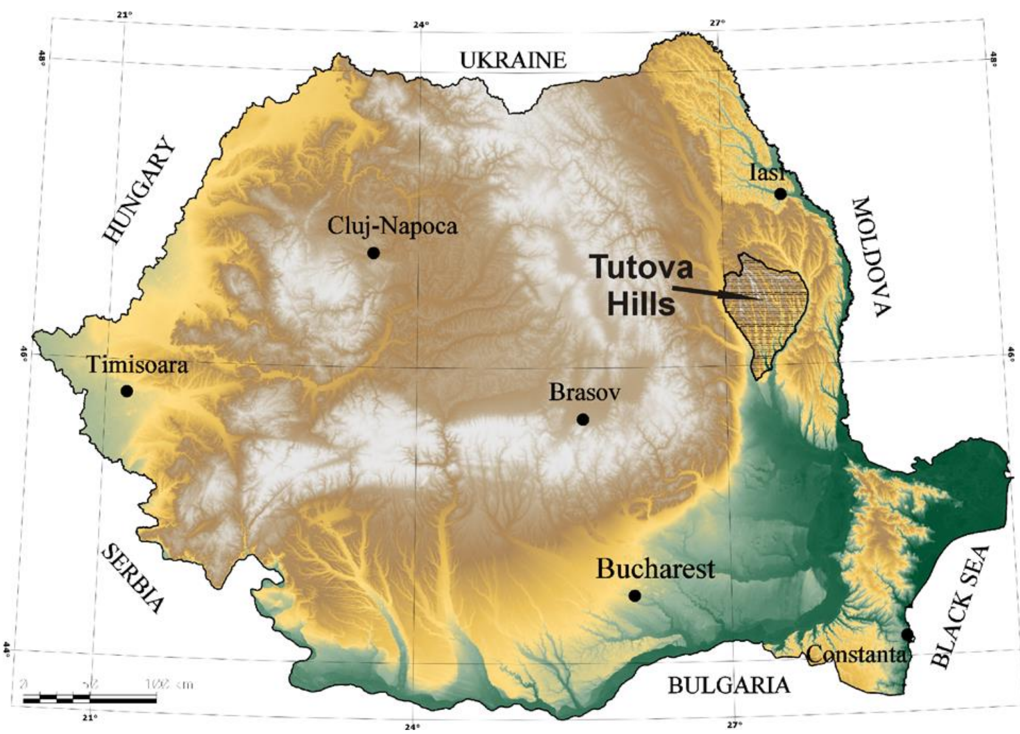


Figure 12. Location of the study area: Tutova Hills (Eastern Romania)
(Stângă *and* Grozavu, 2012)

The Pereschiv River is situated in the central-southern part of Tutova Hills, a basin with an area about 23.266,768 ha (Figure 13).

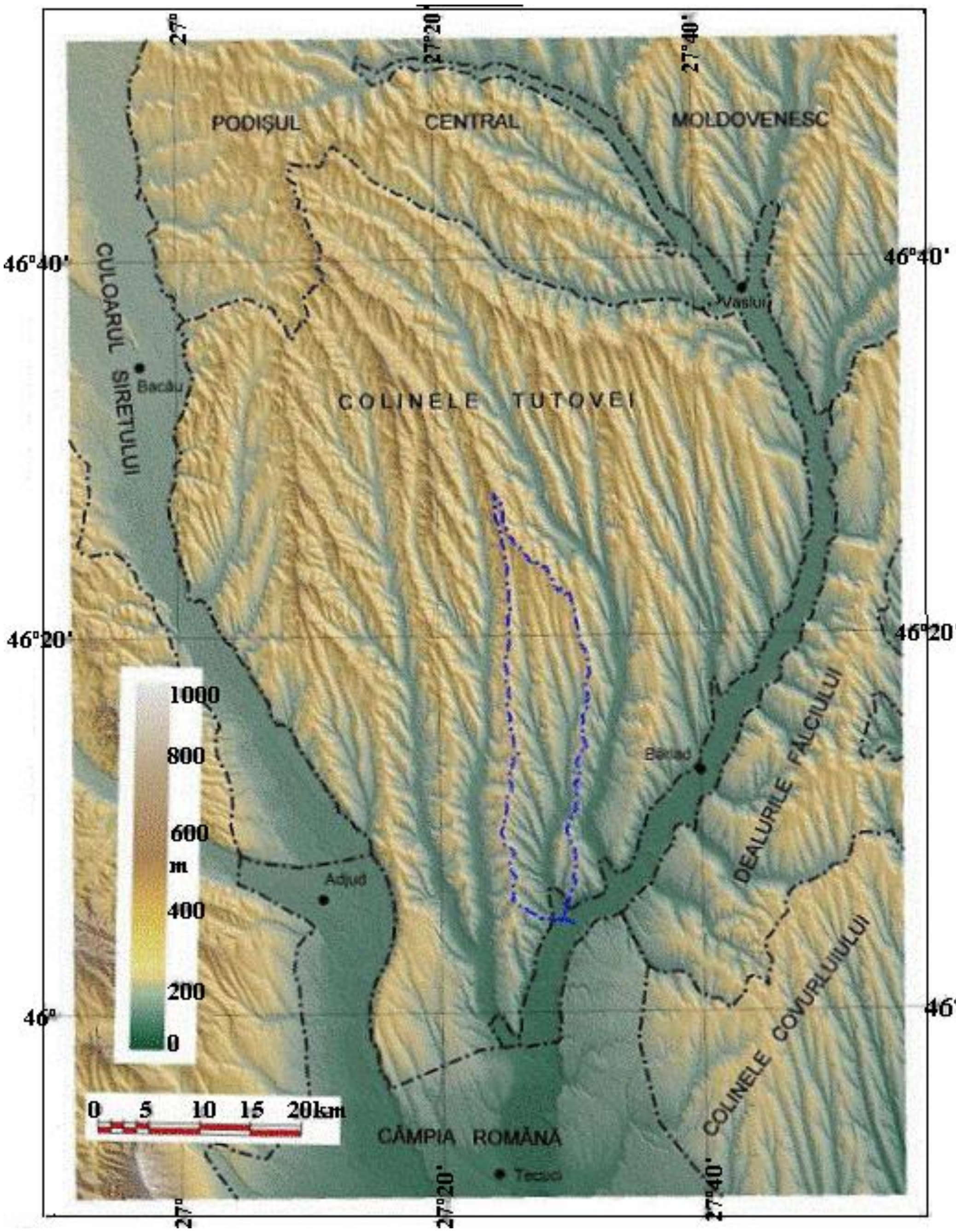


Figure 13. Geographical location of Pereschiv basin, in Tutova Hills
(after Niacşu, 2012)

The geologycal bedrock of this area is generally made of slightly loose deposits, represented by a sequence of sands and clays belonging to the sedimentary couverture of Bârlad Platform.

The territory of Tutova Hills draw up an independent geo-morphological unit, whose limits are well expressed by morphological and morphogenetic criteria.

The geographical position of Tutova Hills, in a temperate climate region with a clear distinction of seasons, determines a certain combination of bark modeling external factors and rhythmic deployment of geo-morphological processes.

Many studies, surveys and inventories (Hurjui *et al*., 2008; Ioniţă, 1997, 2000, 2007) showed that on the slopes have arisen or may arise degradation processes, such as surface and depth erosion. Better management of slopes leads to a higher agricultural production and protection against all forms of degradation, decreasing the potential loss of production, environmental pollution or other damage to agriculture (Râclea, 1999).

Vaslui County is the area with the most active and intense degradation processes of erosion and landslides in Romania.

Analysis of data from National Monitoring System of Agricultural Soils Quality in Romania (2010), revealed the following issues:

Soil erosion in Romania occurs on 6 million hectares, and 700 000 hectares are affected by landslides. Annually, 150 million tones are lost by soil erosion, including 1,5 million tonnes of humus (Dumitru *et al*., 2000, 2004). Total erosion on agricultural land varies between 3,2 and 51,5t/ha/year (Bălteanu *and* Şerban, 2005). Although anti-erosion works have been performed on large areas, these works have not always achieved the expected goals.

Other environmental problem is the tendency of depletion of soil humus and the nutrient content, being known that humus is the most stable form of organic matter that ensures the soil stability. Microorganisms through mineralization annually decompose about 2% of humus. As the content of soil organic carbon, humus is a key indicator of soil quality and fertility due to its positive influence on physical, chemical and biological soil properties (Karlen, *et al.*, 2001; Sparling *et al.*, 2003; Ştefanic, 2006; Ulrich *et al.*, 2006; Ailincăi, 2007; de Castro Lopes *et al.*, 2012).

Decrease in humus content destroy the soil structure, aero-hydric regime, increases phenomena of the watering lands, low buffering capacity, finally reduce agricultural production.

In Tutova Hills area, the current geo-morphological processes, both on the slopes and plains of vineyards, contribute to the degradation of important agricultural areas. Heavy erosion, landslides and active clogging plains, removes an important part of the upper horizons of the soil, reducing soil fertility and some agricultural lands are completely or partial taken out of economical circuit (Figures 14 and 15). Tutova Hills area hydrographic network is formed by a series of streams, of which the most important is the Bârlad River. Hydrological regime of these waters is not uniform, having very large flow variations.

Figure 14. Gully erosion in the southern part of Pereschiv basin, Tutova Hills

Figure 15. Landslides in the southern part of Pereschiv basin, Tutova Hills

5. 1. The main physical and geographical coordinates

Pereschiv River is right affluent of the Bârlad River, the confluence appears in the locality Ghidigeni. From North to South, the basin has a length of 41,3 km, the maximum width is 8,4 km West - East direction. The studied area has a length of 25 km and a width of 7,8 km and is situated in the Southern part of the Pereschiv basin (Figure 16). The area belongs to four communes (table 20):

Table 20. The administrative territories of Southern part of Pereschiv basin
(modified after National Census, 2011)

Nr. crt.	Commune	Number of hectars
1	Podu Turcului (Bacău county)	4065,94
2	Bogheşti (Vrancea county)	2787,64
3	Iveşti (Vaslui county)	132,07
4	Priponeşti (Galaţi county)	2936,41
Total		*9922,06*

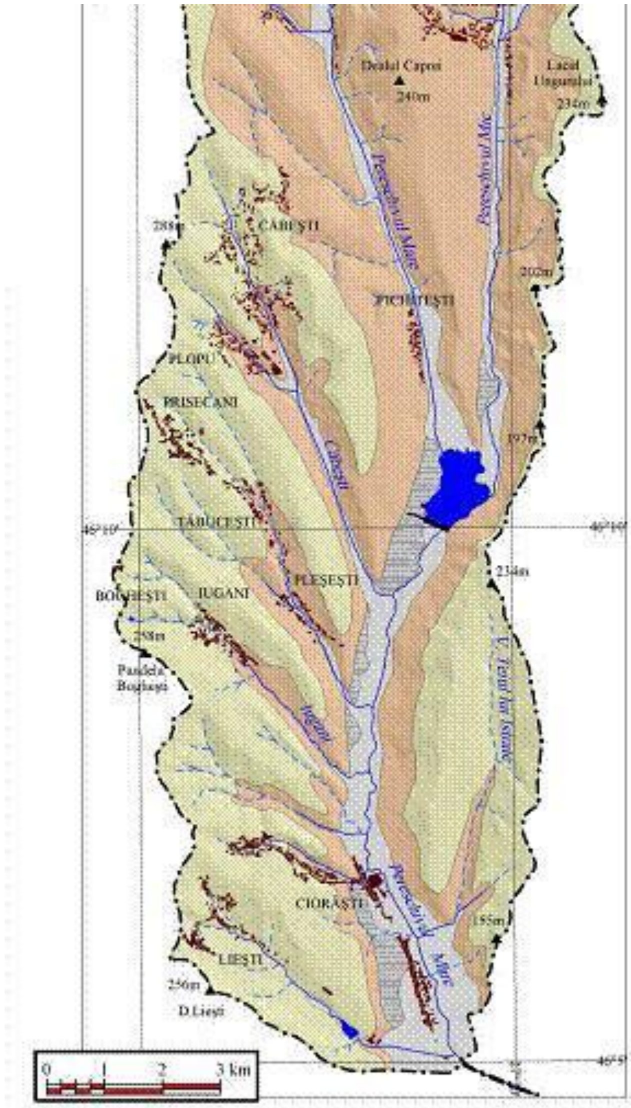


Figure 16. The southern part of Pereschiv basin, Tutova Hills (original)

The GIS coordinates are 46° 11’ 30. 76” N and 27° 29’ 45. 69” E (Figure 17).

Figure 17. The southern part of Pereschiv basin, with villages located on map
(after Google Earth)

5.1.1. Geology and lithology

This basin developed on the deposits placed in the superior part of the sedimentary cover of the Bârlad plateau and the Moldavian plateau.

In the Pereschiv basin, erosion has unearthed only Superior Badenian-Romanian deposits, although Ionesi L. (1994) identifies 4 cycles of sedimentation: *Inferior Devonian–Carbonifer*, *Permian–Triassic*, *Jurassic–Cretacic–Eocen* and *Superior Badenian–Romanian.* In the sediments brought to the surface, predominant deposits are Maeotian, Pontian and Dacian with recent alluviums, but the studied basin area is essentially Maeotian.

Maeotian deposits occupy most of the basin, but toward the South, because of the monoclinal structure, these deposits is sinking more and more, being covered by the Pontian and Dacian deposits (Figure 18). In 1971, Jeanrenaud P., defines two distinct Maeotian horizons: the basic "cineritic horizon of Nuţasca - Ruseni" and above this, the superior clay horizon.

The cineritic horizon is composed by three cinerite banks, of 30-40 m, separated by sandy deposits and clayey marls. The cinerites are visible because of the erosion exerted by some right affluent of Tutova River.

The superior horizon is composed by a series of sands, clayey sands and clay. These deposits are in a strong connection with a fossil Mollusca fauna: *Congeria panticapaea, Unio moldavicus, Unio weltzeri, Psilunio subrecurvus,* specific for sandy and sandy-clayey deposits. Also, there is a fossil mamiferous fauna: *Hipparion moldavicus, Gazella deperdita caprina, Dinotherium gigantissimum* etc.

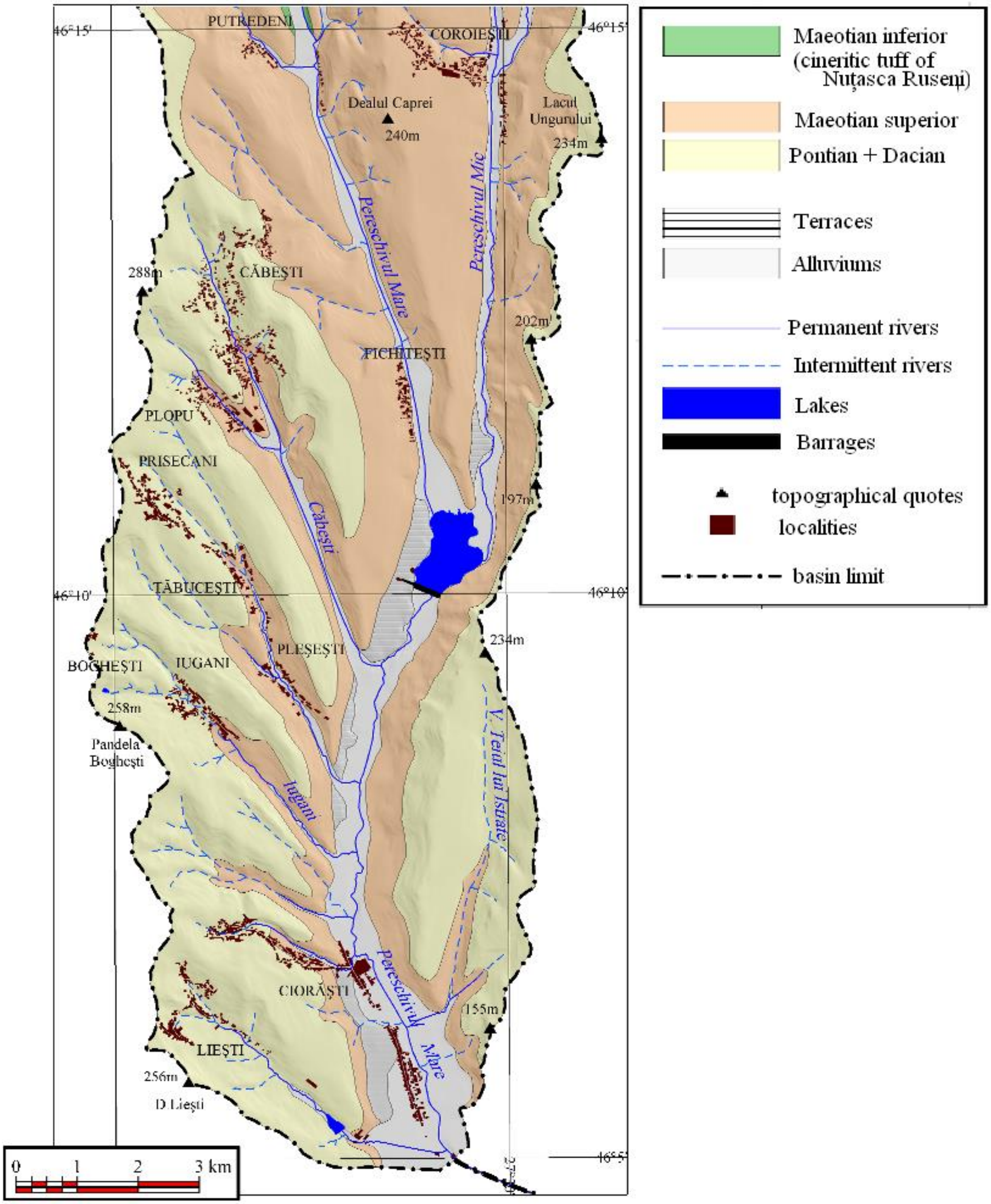


Figure 18. The geological map of the Southern part of Pereschiv basin
(modified after Niacşu, 2012)

The Pereschiv basin developed especially on the Superior Maeotian sandy-clayey deposits (Figure 19).

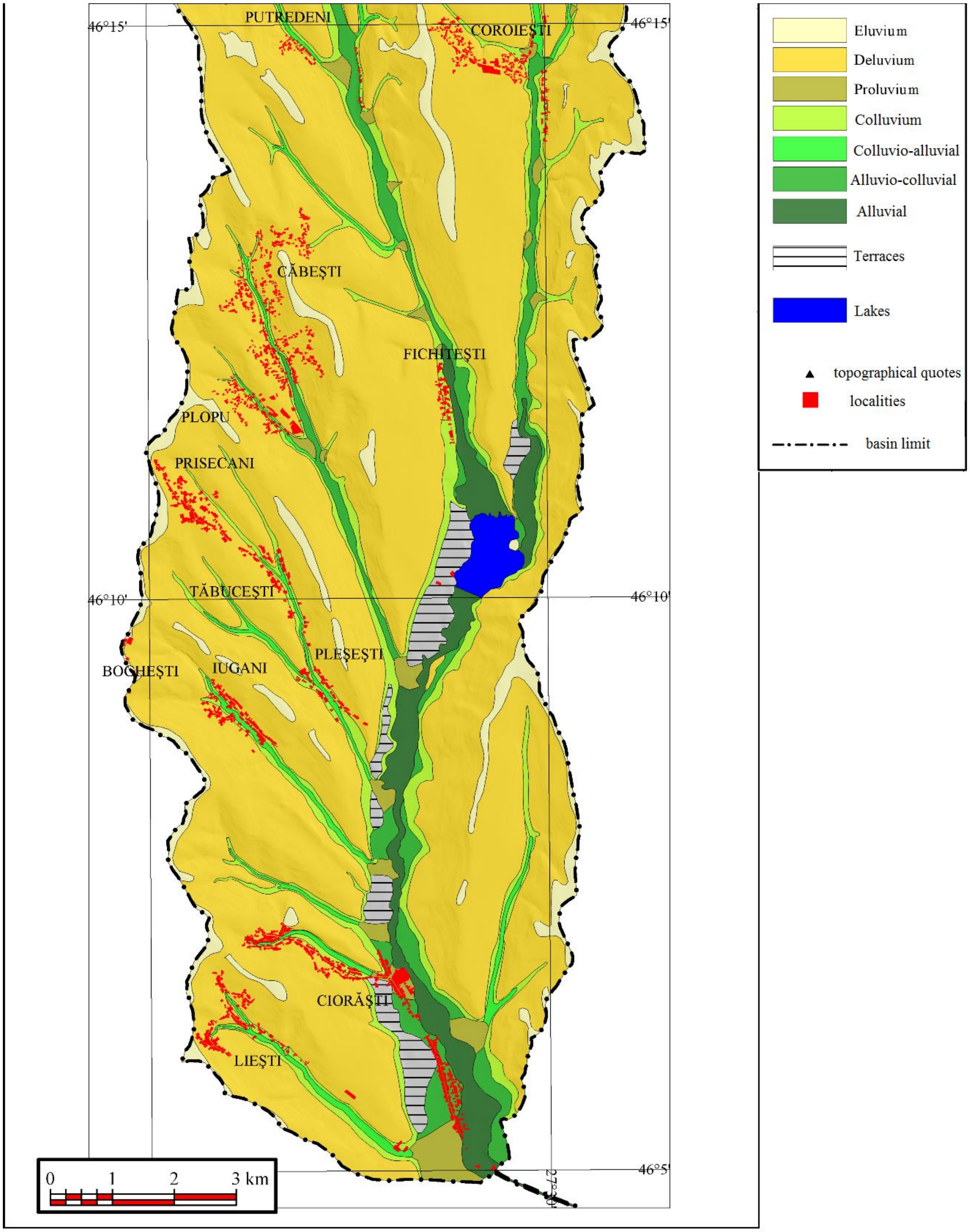


Figure 19. The surface deposits map of the Southern part of Pereschiv basin
(modified after Niacşu, 2012)

Internal factors like lithology and structure have played an important role in shaping the Pereschiv basin, but overall morphology is due to sculptural activity of external factors, which essentially change the initial accumulation plains. It should be noted that in early Pontian, the sea had already withdrew from the Northern Tutova Hills, revealing a low plain. Then, at the beginning of the Quaternary, everything was dried in the Tutova Hills, revealing the actual hydrographic network (Ionesi, 1994).

Denudate has a lead role in shaping the basin, by the combined action of climatic, hydrological, biotic and anthropogenic factors. How was modeled basin Pereschiv we can see in figure no. 18, which represents the surface deposits map, or the parental materials.

5.1.2. Geomorphology

In the studied area, we found sculptural fluvial-denudate landforms with a monoclinal structure and forms of accumulation relief. We encounter a fragmented landscape in the form of elongated interfluvial ridges, North to North West/South to South East oriented, separated by a network of valleys surrounded by a set of cuesta (marbles).

In the basin area, was modeled a *sculptural relief*, constituted by sandy-clayey inter-fluviums affected by geomorphological processes like gullying erosion, piping erosion, landslides, crumbling. The main geo-morphological processes are pluvial erosions by rainfalls and active versant processes.

Along the Pereschiv valley and tributary rivers, it appears an *accumulation relief* represented by alluvial plains and accumulation glacis (Niacşu, 2012) (Figure 20).

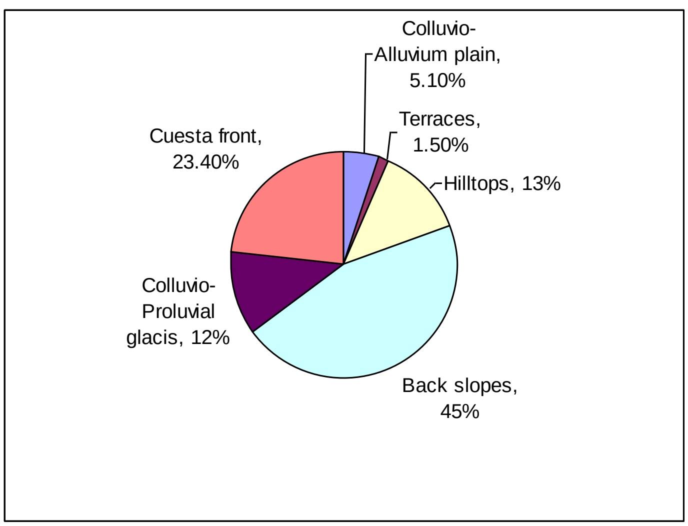


Figure 20. The relief forms on Southern Pereschiv basin
(modified after Niacşu, 2012)

According to figures 20 and 21, we can conclude that structural relief forms cover over 80% of the basin, and over 70% are denuding forms influenced by the monoclinal structure of the geological substrate.

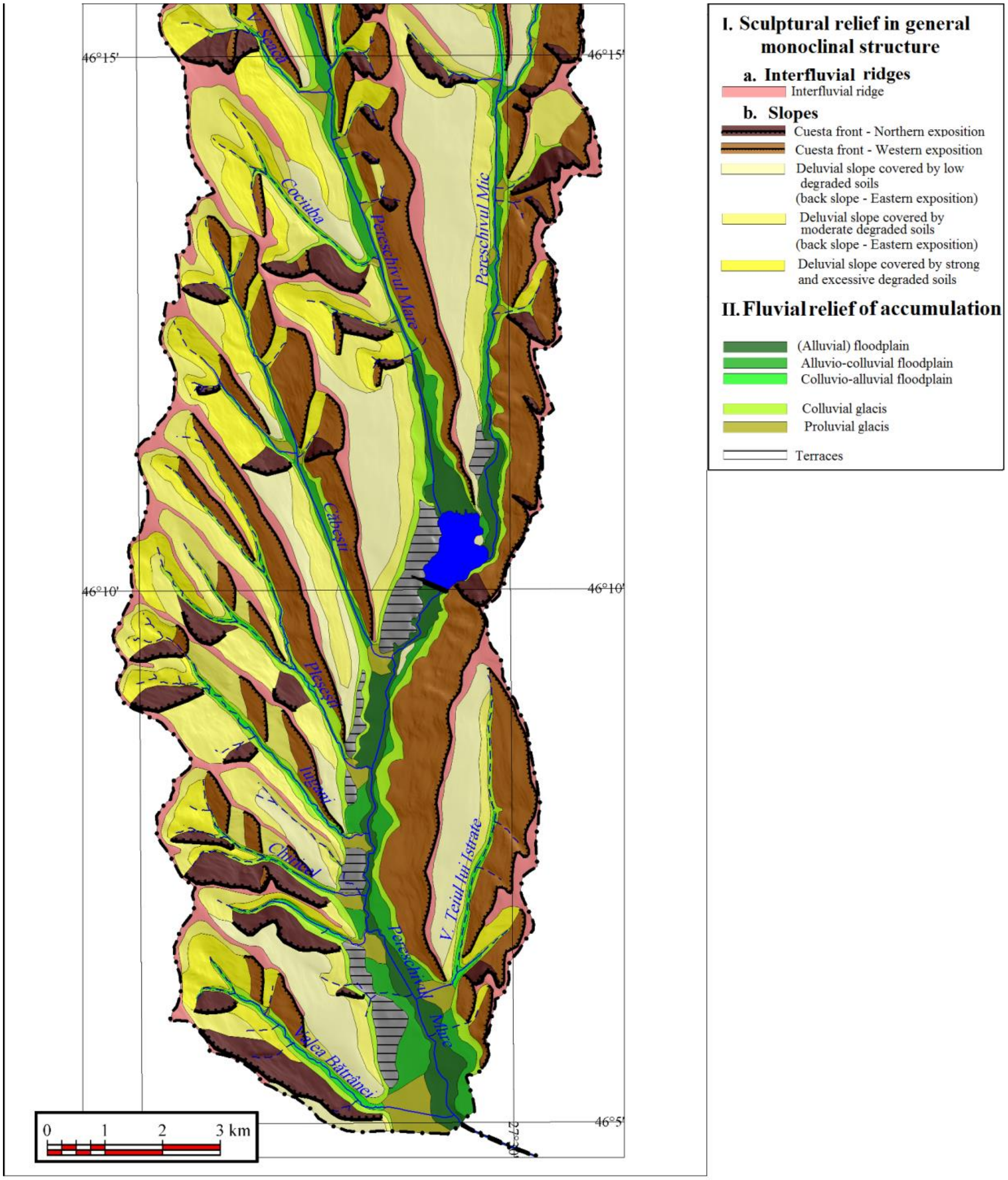


Figure 21. Geomorphological map of Southern Pereschiv basin
(modified after National Meteorological Agency)

5.1.3. Climate

The climate impact represents an important factor in modelling the basin relief, this impact becoming essential after the sea withdrawal in the early Pontian.

There are four weather stations in Tutova Hills: Plopana, Vaslui, Onceşti and Bârlad. The average annual temperature in Tutova Hills is 8.8°C at Onceşti and 9.6°C at Bârlad. The monthly average varies widely, from -2.8°C in January to 20°C in July. The highest temperature ever recorded was 38.9°C and the lowest was -32°C (National Meteorological Agency).

We can observe that the average annual air temperature (Figure 22) is a little lower than temperature of the soil cover (Figure 23). The large variations of soil and air temperature have major effects on rocks disintegration. The material is detached in the winter months due to freezing and the transport of this material begins in the springtime, due to thawing and melting (Niacşu, 2012).

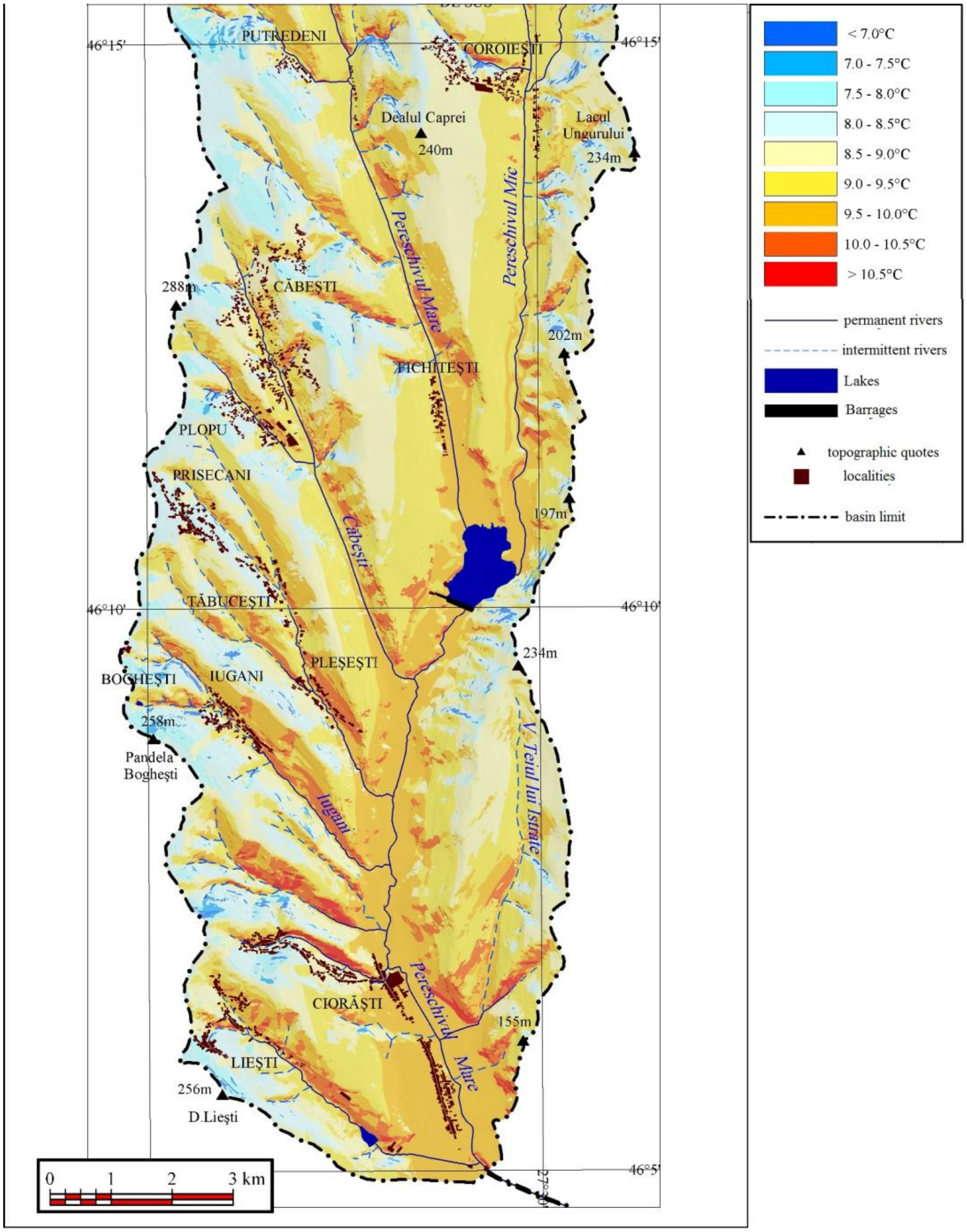


Figure 22. The average annual air temperature (1961-2011)
(modified after National Meteorological Agency)

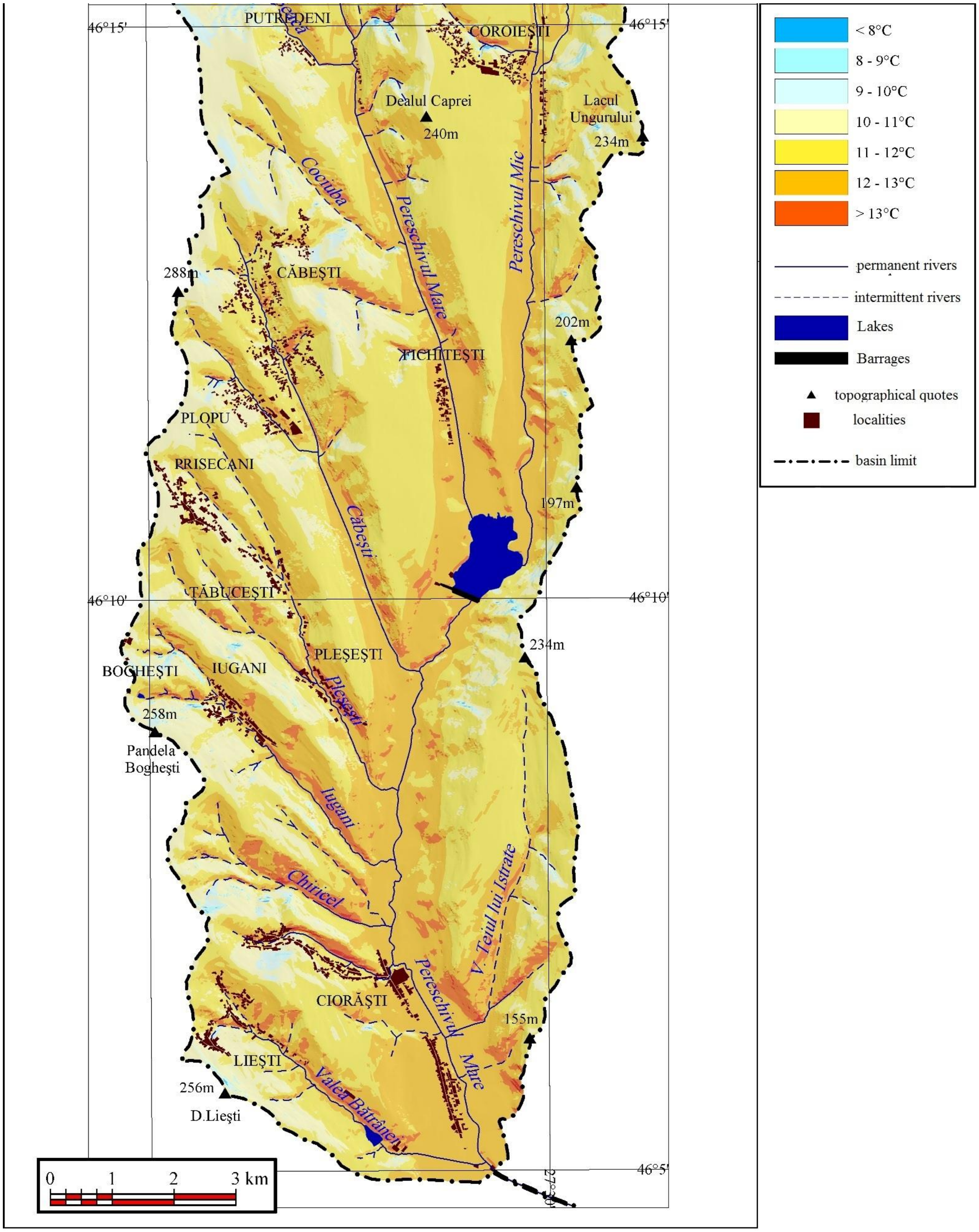


Figure 23. The average annual soil temperature (1961-2011)
(modified after National Meteorological Agency)

The rainfall in Pereschiv basin is 515,5 mm/year (Figure 24).

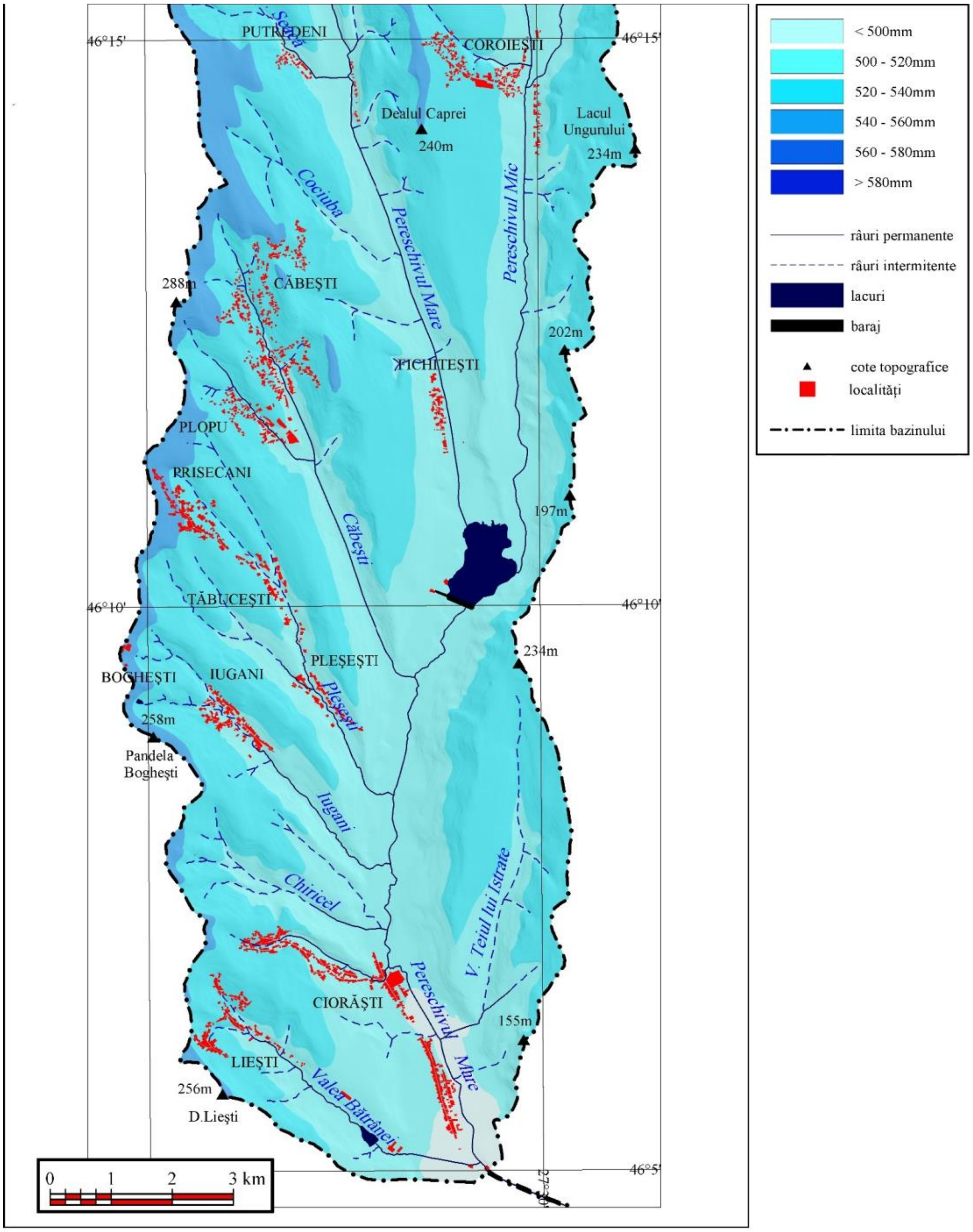


Figure 24. The average annual rainfall in Southern Pereschiv basin
(modified after National Meteorological Agency)

According to Pujină D. (1997), in 1829-1992 period, in Bârlad Plateau were 26 drought years and 35 rainy years. The torrential rainfalls are more frequent than drought and once or twice/year there are hailstorms. In the warm season, is registered around 66% of total precipitations, the rest of 34%, in the cold season. The critical period of erosion in one year, is between 20th of

May and 20th of July. The persistency of snow cover on the soil is around 60 days/year (Ioniţă, 2000, 2007).

In Romania, in the 1900-2004 period, the multiannual fluctuation of annual average precipitation (Figure 25) shows significant variability from year to year, highlighting a descending trend. One of the limiting factors with negative effects on the productivity of field crops was the rainfall. As a negative effect of rainfalls in the investigated area, most of the volume of eroded material, results from the process of gullying. The largest amount of material removed from gullies occurs in spring, so surface erosion reaches its peak in late spring and a lower level in autumn season (Ioniţă, 2000).

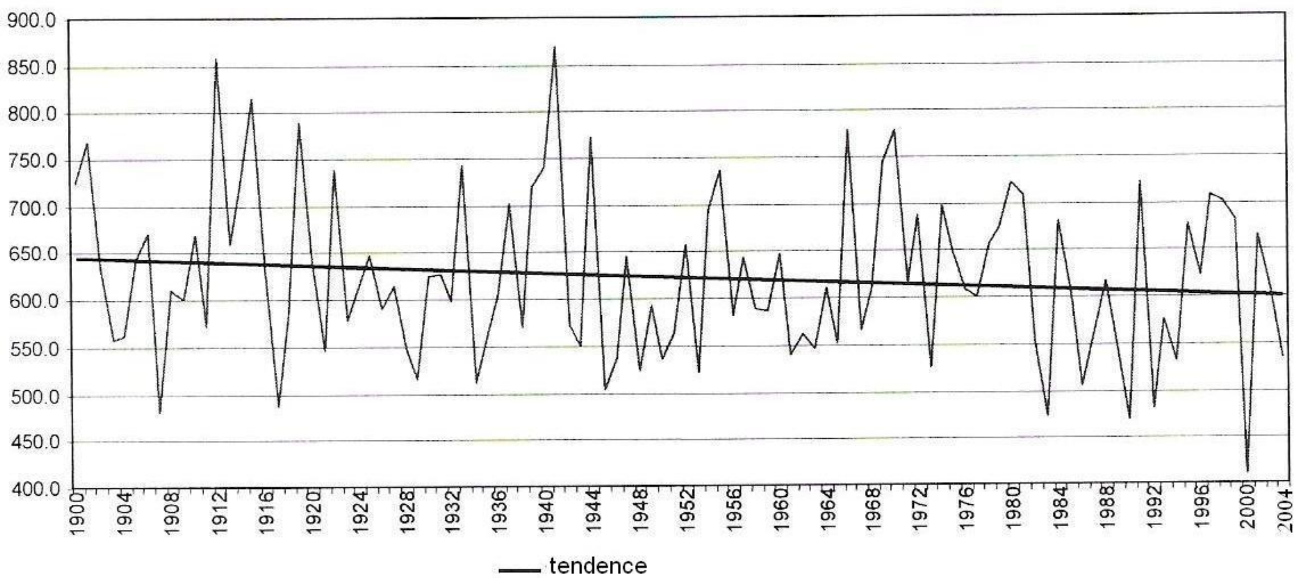


Figure 25. The annual average precipitation in Romania in the 1900-2004 period (after National Meteorological Agency, 2007)

Year 2007 was excessive dry because of the soil water deficit and the extended period of drought. It was an droughty winter with little snow, so that the drought has been installed since May and has remained during the entire summer. Drought has been accentuated by high temperatures (over 2,5°C above average) which led to earlier phenophases of crops with about 4 weeks, increasing their sensitivity to water stress. Autumn crops have critical period between May and June. But exactly in this period were extremely low rainfalls, running rapidly from atmospheric drought to pedological drought. Because of the heat stress and water shortage, the weeding plants appeared with a very low size, wilting and rolling leaves. Under the conditions of very high temperatures, the intense evapotranspiration of soil water caused negative effects on crops, especially sunflower and maize. Due to lack of irrigation systems in the investigated area, it was reached the wilting coefficient, the corn crops being affected at a rate of 90-100%. The crops were used only for animal feeding. Grain yield dropped below 300kg/ha. Nor fodder or hay were not developed enough so that the animals were not fed properly, and their price dropped to less than 25% of their normal price. Small amounts of precipitation led to lowering the undergroundwater level and wells drought up. Drinking water sources were seriously compromised.

The aridity index is an indicator expressing the water deficit in an area. Figure 26 highlights the territorial distribution of aridity index R, calculated from the *ratio between the volume of rainfall and potential evapotranspiration*.

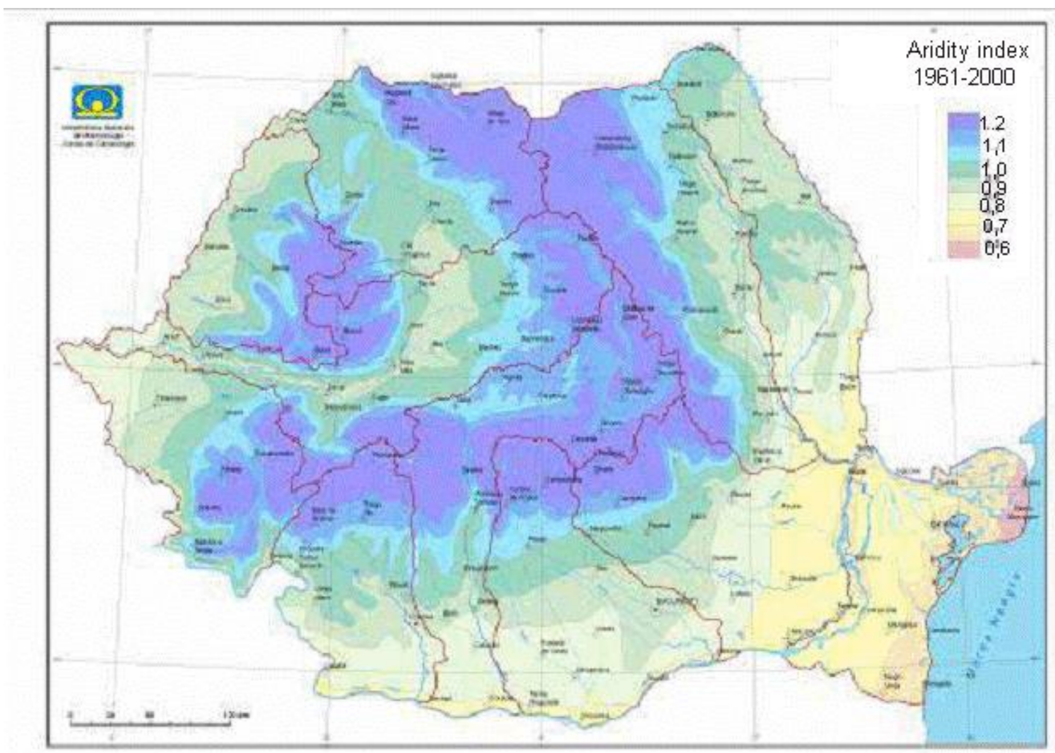


Figure 26. Territorial repartition of aridity index (R), 1961-2000
(National Meteorological Agency, 2007)

Low values of the index of aridity R indicate a high degree of aridity of the area, as in Dobrogea, Eastern Bărăgan and Southern Moldova, and the southern extremity of the Romanian Plain. These regions have a natural background, favorable for a significant impact of drought. Drought however, is a phenomenon that can occurs in any geographical conditions and the impact can be important even in regions where R index has high values in annual average. According to UNCCD (United Nations Convention to Combat Desertification), the most exposed zones to desertification are those with a R index between 0,05 – 0,65. The humid regions with R > 0,65 and hiperarid regions with R < 0,05 are not exposed to desertification.

In my investigated area, the aridity index (R), established by the National Meteorological Agency, is around 0,8 which corresponds to a semihumid climate (Figure 26).

The value that expresses the relationship between climate, vegetation and waters of a territory is the aridity index "Emm. de Martonne" (**I_A**), calculated from the average of multiannual average rainfall amount and multiannual average temperature values. It is expressed by the formula ***$I_A = P/T + 10$*,** where P represents the value of multiannual precipitation and T is annual average temperature. Additional intervenes the value of 10°C to produce positive results in regions with negative annual average temperatures, such as deserts or alpine mountain regions at mid-latitudes.

De Martonne index shows very clear which areas are predisposed to drought (Figure 27). The semihumid and semiarid areas are most affected by water deficit.

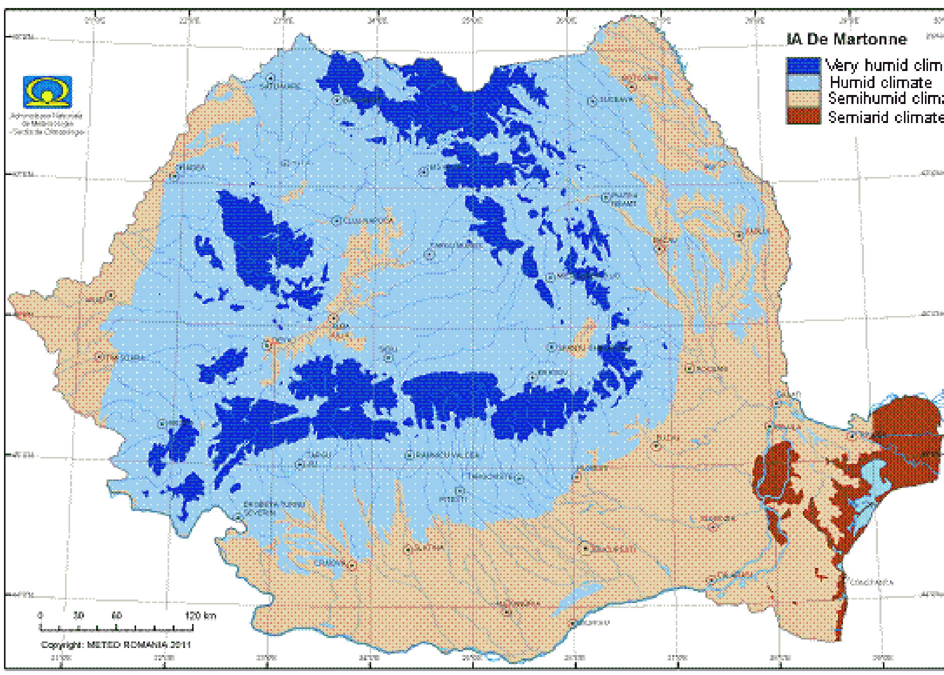


Figure 27. De Martonne aridity index (I_A) in Romania
(National Meteorological Agency, 2007)

Taking into consideration that in my investigated area, in the period 1961-2011, the average multiannual rainfall is 515,5/year and the average multiannual temperature is 9°C, De Martonne index is $I_A = 515,5 / 9 + 10 = 27,13$. We can conclude that in my investigated area, the climate is semihumid, subtype forest steppe (Table 21).

These two indexes, R and de Martonne, lead us to the same conclusion, that in the investigated area the climate is semihumid.

Table 21. numerical correlation of De Martonne index with the characteristic climate (Satmari, 2010)

Index Value	Climate	Subtypes
0 – 5	*Hiperarid* - absolute deserts, extremely arid	
5 -10	*Arid* – desert regions	
10 – 15	*Steppe* - semiarid climate, mediteranean	Dry steppe
15 – 20		Steppe with gramineae
20 – 25	*Semihumid*	Steppe with tall grass
25 – 30		Forest steppe
30 – 35		Oak forest
35 – 40		Beech forest
40 – 45		Coniferous forest
45 – 50		Subalpine
50 – 60		Alpine
> 60	*Perhumid*	

In Southern Pereschiv basin, the underground water has an ascending or artesian way, with a low hardness and is considered suitable to drink (Figure 28).

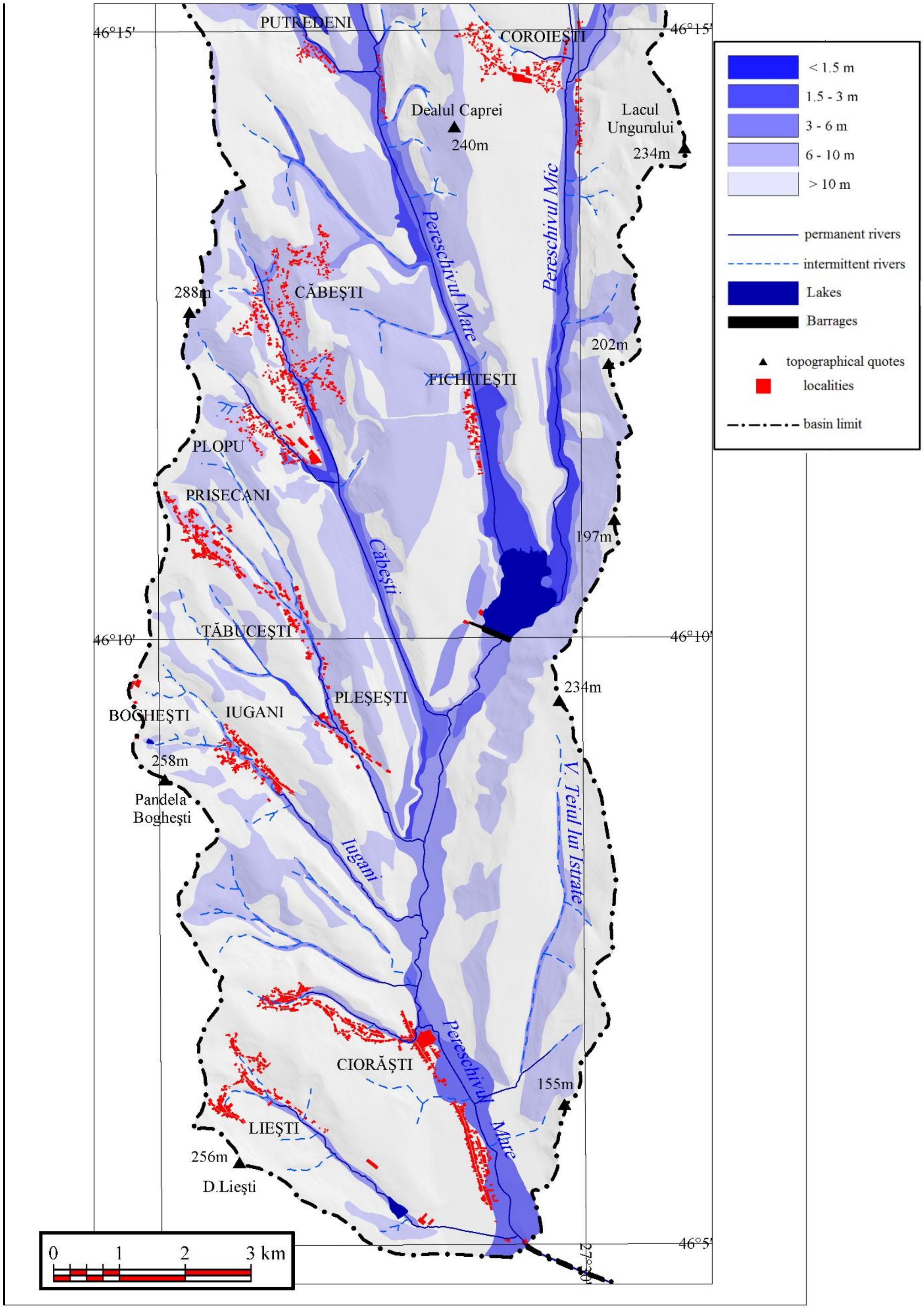


Figure 28. The underground water in Southern Pereschiv basin
(modified after Niacşu, 2012)

The accumulation lake Fichiteşti has a surface of 231 hectars, a volume of 16.5 million m^3 and a length of 3 km. This lake allows mitigating the negative aspects of temperature and air humidity. The Pereschiv River and Fichiteşti Lake are almost dried up at this moment, due to excessive and prolonged drought in 2012.

5. 2. Vegetation and fauna

Florea (2005) includes the Bârlad Plateau in the **CO domain** of the steppe and forest steppe in the low hills (hillocks) and hills substituted by agroecosystems that belongs to moderate temperate zone and moderate wet sub-zone.

The flora of the region shows considerable variation due to landforms, altitude, substrate and the climatic factors, which influence the distribution in time and space of species.

By the steppization held after human intervention, mainly through deforestation, xerophylous elements conquered more and more land, sometimes infiltrating into the northern part.

Species distribution is as follows: 67,85% mesophilic species, 24,15% xerophyte species, 4,75% hygrophile species, and 2,25% hydrophile species.

In the early XIXth Century, the forest distribution in Tutova Hills was approximately 48%, but in the middle of XXth Century, the distribution was 19%, due to irrational exploitation.

The vegetation consists of forest steppe species and deciduous forests. In this area are characteristic sessile oak forests (*Quercus petraea*) mixed with *Quercus pedunculiflora* (gray oak) and *Quercus pubescens* and rare *Quercus frainetto*.

In the Pereschiv basin, there are two zones of vegetation, which make the difference between latitude and altitude.

The *forest zone* (the vertical one) is situated on 250-300 m altitude and it is composed by two subzones:

- *sessile oak* and *beech* subzone, in northern part: *Quercus petraea, Fagus silvatica, Carpinus betulus, Ulmus montana, Acer platanoides, Acer pseudoplatanus, Tilia cordata* and *T. tomentosa*.

- *sessile oak* and *oak* subzone, in southern part: situated on lower altitudes, being a mixture of: *Quercus petraea and Q. robur*. We can also find species of *Acer sp*., *Ulmus campestris, Tilia sp*. Very close to the forest steppe zone there are thermophile species as *Quercus pubescens* and *Q. pedunculiflora.* The shrub trees are represented by *Corylus avellana, Cornus mas, Viburnum opulus, Ligustrum vulgare, Malus silvestris, Pyrus silvestris,* together with forest steppe species as *Rosa canina, Prunus spinosa, Crataegus monogyna*.

The herbaceous species are *Poa nemoralis, Brachypodium silvaticum, Fragaria vesca, Viola odorata, Convallaria majalis*. The forests have been extensively cleared the land being later used for agriculture (Niacşu, 2012).

The *forest steppe zone* (the orizontal one) is characterized by herbaceous vegetation interrupted only by some clumps of forest: *Quercus* and *Tilia* species. The herbaceous species is composed by:

■ Endemite species: *Euphorbia villosa ssp. valdevillosocarpa, Jurinea mollis ssp. transsilvanica, Ornithogalum orthophyllum ssp. Psamophyllum*;

■ Pontical species: *Agropyron cristatum ssp. sabulosum, A. stylosa, Agrostis moldavica, Allium guttatum, Anchusa gmelinii, A. stylosa, A. thessala, Bellevalia sarmatica, Centaurea arenaria ssp. borystenica, C. salonitana, Colchicum fominii, Dinthus platyodon, Elymus elongatus ssp. ponticus, Festuca beckeri ssp. polesica, Galanthus elwesii, Nepenta ucranica, Onosma visianii, Ornithogalum fimbriatum, Palimbia rediviva, Pyrus elaeagrifolia*;

■ Balcanic species: *Achillea depressa var. depressa, Centaurea euncifolia ssp. palida, Dianthus pallens, Paeonia peregrina, Peucedanum rochelianum, Ranunculus constantinipolitanus, Stachys angustifolia, Thymus comptus*;

■ Mediteranean and atlantic-mediteranean species: *Chamaesyce peplis, Erucastrumgallicum, Nectaroscordum siculum ssp. bulgaricum, Teucrium botrys, Viola hymettia*;

■ On recently formed soils are common *Poa pratensis, P. bulbosa, Festuca drymeja, Dactylis glomerata, Equisetum arvense, Trifolium repens*;

■ In the semihumid habitats are common: *Phleum pratense, Taraxacum officinalis, Arrhenatherum elatius*;

■ Humid soils that tolerate short term flooding are populated by*: Ranunculus acris, Rorippa sylvestris, Polygonum lapathifolium, Equisetum telmateja, Juncos inflexus, Carex vulpine;*

■ Frequently flooded and submerged soils: *Carex riparia, Phragmites australis,* and *Alisma plantago-aquatica, Schoenoplectus lacustris, Sparganium erectum, Eleocharis palustris.* On very small areas were identified species like *Polygonum amphibium, Lemna minor and Potamogeton natans,*

In the areas occupied by salinised soils there are characteristic species of *Salicornia herbacea, Sueda maritima* and *Artemisia austriaca*. The most forest steppe areas are cultivated with agricultural species (Niacşu, 2012; GAL Colinele Tutovei, 2012).

The fauna is specific to forest steppe and forest.

The forest ecosystems fauna is composed by a large number of invertebrate fauna: gastropods, spiders, insects and millipedes. The most common arthropods are Acari (*Eutrombidium sp*.), Opiliones, Araneea, Pseudoscorpiones, Lithobiidae, Forficulidae, Braconidae, Ichneumonidae, Carabidae, Staphylinidae, Dermestidae and Lampyridae.

The vertebrate fauna is represented by:

■ Amphibians - *Triturus vulgaris*, *Salamandra slamandra*, *Bombina variegata*, *Bufo bufo*, *Rana temporaria*, *Hyla arborea*.

■ Reptiles - *Lacerta agilis*, *Natrix natrix*, *Coronella austriaca*.

■ *Birds* - *Dendrocopos major*, *Picus canus*, *Ficedula albicollis*, *Muscicapa striata*, *Fringilla coelebs*, *Passer montanus*, *Coccothraustes coccothraustes*, *Parus major*, *Parus coeruleus*, *Sitta europaea*, *Turdus merula*, *Luscinia megarhynchos*, *Erithacus rubecula*, *Sylvia atricapilla*, *Sylvia communis*, *Phylloscopus collybita*, *Lanius collurio*, *Sturnus vulgaris*. Among diurnal raptors are found: *Accipiter* sp., and the nocturnal species are: *Athene noctua* and *Strix* sp.

■ *Mammals* – the most important species are for hunting purpose: *Capreolus capreolus*, *Sus scrofa*, *Vulpes vulpes*. The small nocturnal mammals are: *Apodemus sylvaticus*, *Cletrhionomis glareolus*, *Sorex araneus*, *S. minutus*, *Erinaceus europaeus*, *Talpa europaea*, (familia *Myoxidae*) (GAL Colinele Tutovei, 2012).

The soil fauna, classified as mezofauna, microfauna, macrofauna and megafauna, is represented by invertebrates and vertebrates.

The mezofauna is represented by acari, myriapods, warms and small arthropods. The microfauna is represented by protozoa, nemathods, rhyzopods.

The macrofauna is represented by insects, mollusca, and soil warms.

Large vertebrates like foxes, snakes, frogs, moles, different type of rodents-hares, mouses, rats, compose the megafauna (Niacşu, 2012).

Wild animals are digging shelters and canals in the soil, the result being a mixed soil and some microforms, like mounds and krotovinas. The herds of sheep and cattle representing the anthropogenic factor, by overgrazing and treading lead to soil erosion, like soil compaction, destruction of soil structure, reduction of soil biological activity, reduction of floristic diversity, ruderalisation of vegetation by replacing the existing valuable species with weeds or even destabilize the slopes.

6
The soils

The soils of Tutova Hills are evidentiated in figure 29, which is the soils map of Tutova Hills.

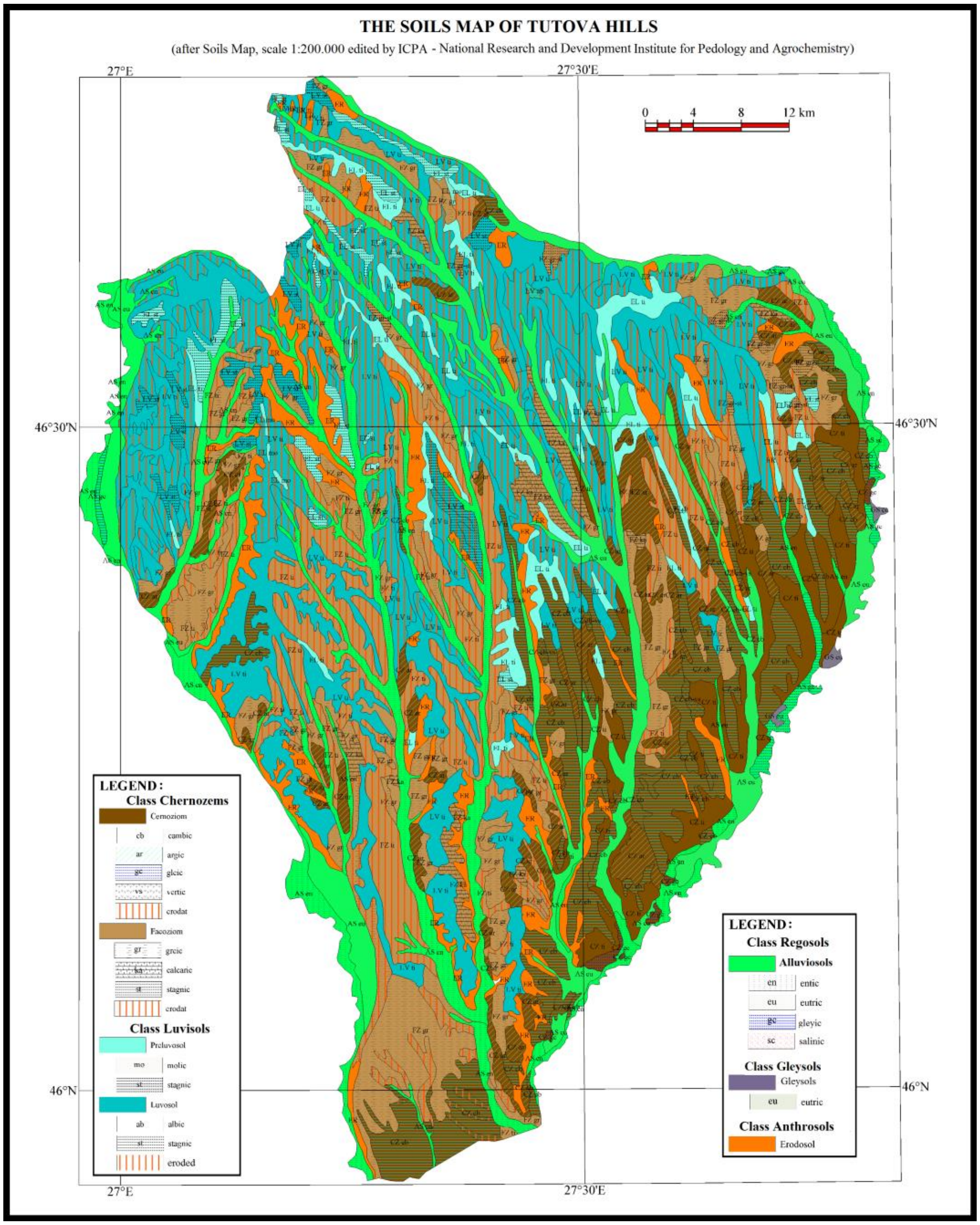


Figure 29. The soils map of Tutova Hills
(After The Soils Map, 1:200.000 scale, edited by ICPA Bucureşti)

Pereschiv basin relief is influenced, firstly, by the effect of the action of rivers, due to erosion, transport and accumulation (Figure 30). For example, the thickness of the silt deposited in Lake Fichiteşti (1977 to present) is over 400 cm. The principal types of accumulation are alluvial-colluvial plains and terraces.

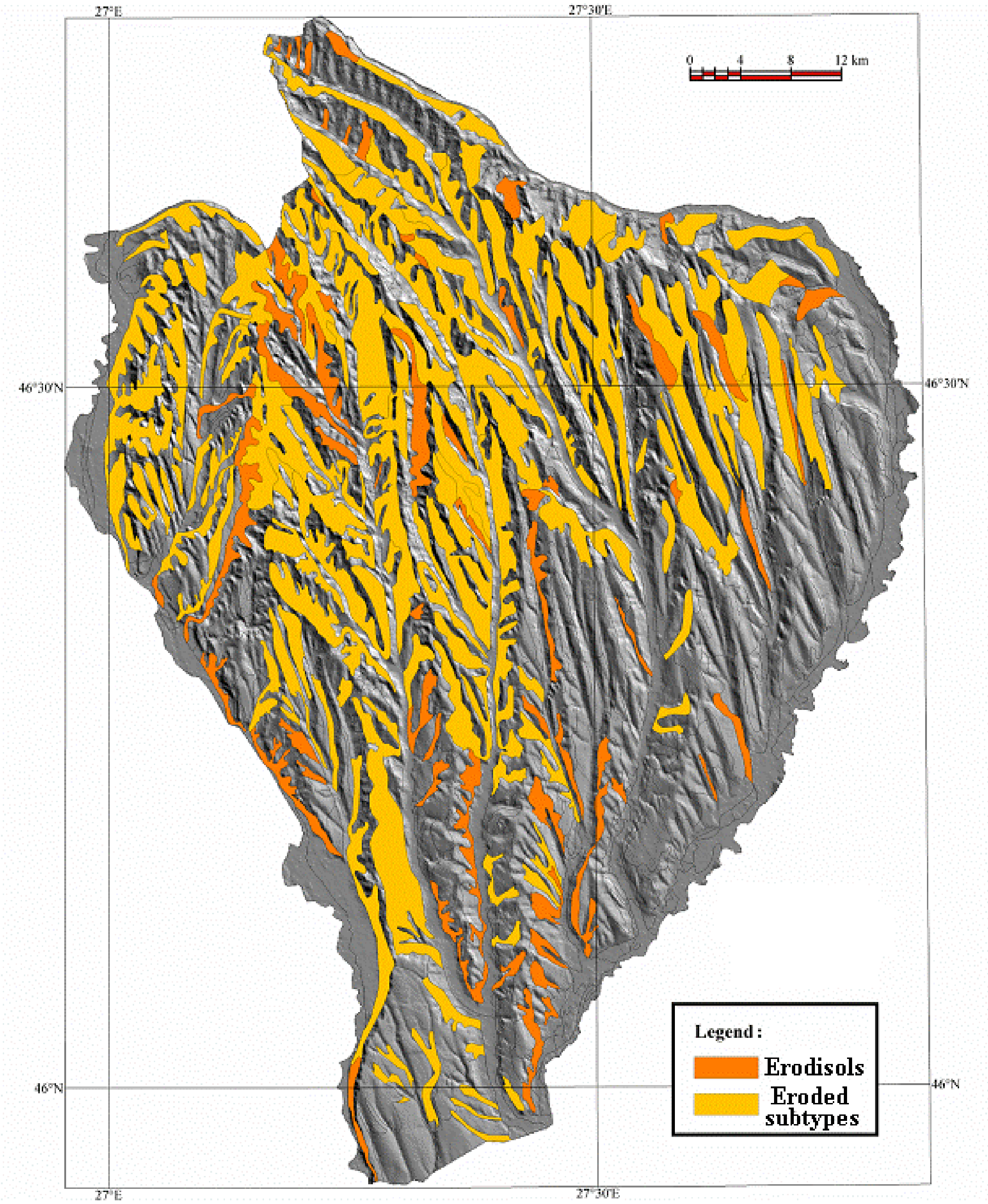


Figure 30. The eroded soils map from Tutova Hills
(After The Soils Map, 1:200.000 scale, edited by ICPA Bucuresti)

Soil erosion, landslides and gleyfication in the county of Vaslui, represent key factors affecting 68,5% of the total degraded agricultural lands in 2009 (211245 ha). Soil degradation occurs due to wind, acid rain and human activities such as: inappropriate agricultural work destroying soil structure, treatments with pesticides and chemical fertilizers.

The erosion in Pereschiv basin is mostly due to surface and depth erosion, slightly landslides and other secondary processes like deflation, compaction, land fallings.

In Pereschiv basin, the most important role in soil erosion are the land using and the vegetation. Over 80% of land are agricultural and 54% of these lands are arable, which confers protection against erosion. The crops with a low protection against erosion are corn and sunflower which covers 72% of arable land. Only straw cereals (wheat, rye) has a good protection against erosion, but they cover 24% of arable land. Currently, out of approximately 4900 hectares of arable land, 60% is cultivated with corn, 24% is cultivated with wheat and rye, 12% with sunflower, but vegetables and potatoes are cultivated on only 2,5% and 1,5%. Vegetables are cultivated only in the extreme Southern part of the territory (Ciorăşti, Galaţi county), in other parts are cultivated only for their own consumption (Figure 31).

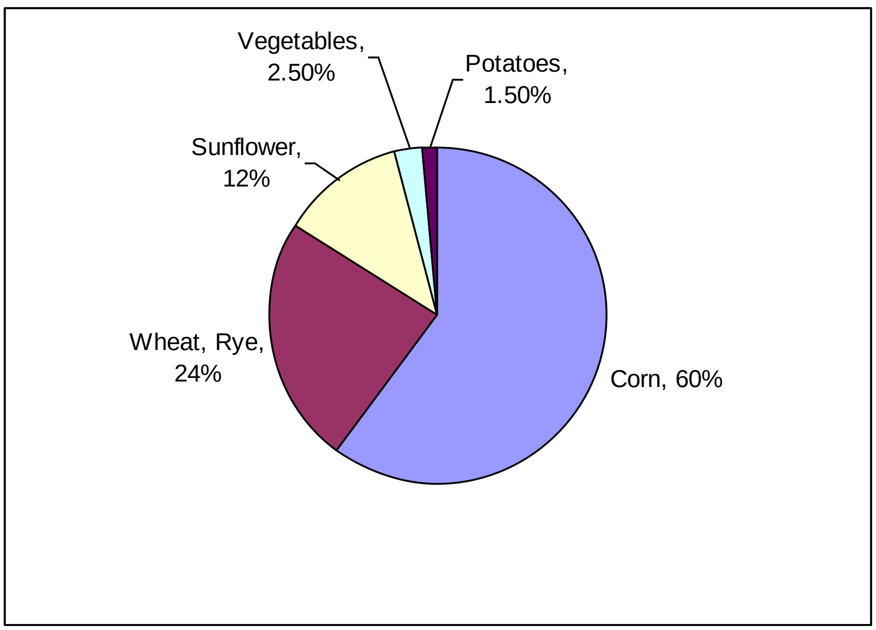


Figure 31. The crops on arable lands

Besides crop structure, it is very important the land use in terms of anti-erosion techniques. Unfortunately, after applying the Law 18/1991, concerning the restitution of lands, the owners returned to cultivation on small plots on top-down direction, which favored accelerated soil erosion (Figure 32).

Figure 32. Culture top-down, North-East of Coroieşti, Pereschiv basin

The forest soils are most exposed to erosion (preluvisols and luvisols) but also cambic and argic chernozems. As a proof of surface erosion high level, is regosols and erodisols which occupies almost 25% of the basin (figure 33). In figure 33 we can see an E horizon exposed by erosion, A horizon being totally removed. The critical season for surface erosion is between 15 May – 20 July.

The depth erosion is represented by gullying. In Tutova Hills, the gully processes are the most active in the country, due to natural and anthropogenic factors. There are three types of depth erosion: big rill (0,2-0,5 m depth), ephemeral gully (0,5-3 m depth) and gully (over 3 m depth). Wind erosion does has an important role in transporting the soil particles.

Figure 33. E horizon, exposed by erosion, Dealul Caprei (Goat Hill), 240 m

Out of all studied area (around 10 000 ha), 80% are agricultural lands and only 20% are not agricultural lands. This fact allows us to conclude that the first vegetal cover, forest and sylvo-steppe natural grassland, was replaced with agricultural lands. Regarding the lands, we found some discrepancies between the official data reported by local administration and the reality of the field, where there are many parts of the land considered as cultivated, being abandoned or degraded (Table 22).

Table 22. The real land status in the studied area (after Niacşu, 2009)

Type of land	**Land status**	**%**
Arable	Arable	89
	Cultivated pastures	8,9
	Abandoned land	**2,1**
Pastures and hayfields	Clean	24,5
	With bushes	**8,5**
	Degraded	**67**
Vineyards	Clean	23
	Degraded	**77**
Orchards	Clean	4
	Degraded	**96**
Forest	Clean	71
	Forest shield	20
	Degraded	**9**
Land with water	Lakes	77
	Swamp	**23**

Tutova Hills (3603 km^2) represents a distinct geographical unit in the eastern part of Romania clearly bounded westward and eastward by two large valleys (Siret and Barlad Rivers).

The field research focused on surveying the sequential soil cover by opening soil profiles and multiple sampling (collected from characteristic horizons and depths).

The **landscape** of Tutova Hills is grafted on predominantly sandy and sandy-loamy deposits and is characterized by an obvious parallelism of the relatively narrow interfluves. Developed between 46 and 561 m of altitude, the region presents steep slopes with a fast dynamics of geomorphological processes (mainly sheet erosion and gullying, secondly landslides). The temperate continental climate is defined by annual mean temperatures between 7,1°C and 10,2°C and rainfalls of about 500–660 mm in a year, but which are characterized by an irregular regime. Except the two major bordering rivers and their floodplains, water resources (groundwater and surface water) are modest in terms of quantity and quality, being at the same time strongly influenced by the climatic variability. From the bio-pedological point of view, the study area is at the limit between the forest domain, dominant in the central-northern part, and the forest steppe that occupies the southern part, influenced by Russian excessive temperate climate: very drought summer season and very cold winters. Isolated, in the low areas along valleys, steppe associations are inserted. In terms of human geography, Tutova Hills are an **exclusively rural** region with a low degree of accessibility and an aged population, generally isolated in small villages, without any infrastructure or technical urban facilities. There are 412 villages, mostly of dissociated type, with about 203.300 inhabitants, more than 90% of the active population being occupied in agricultural activities. The agriculture, dominated by crop production, is characterized by the existence of small plots (often of less than one hectare), insufficient mechanization and ignoring the ecological, agro-technical or economic principles. There are small plots that cannot be maintained by anti-erosion works. The works are made from top to the base, which aggravates the erosion processes, by anthropogenic technological impact.

6.1. General features of Tutova Hills soils

The soil cover represents one of the main natural resources of the world, that was formed over geological time by the shaping action of zonal and local abiotic and biotic factors on the Earth crust. On the Romanian territory, the soil cover has a particular spatial variability, due to the geomorphological, geological and climatical variability, justifying the term of „*museum of soils*” used by Murgoci, founder of Romanian soil science (Bireescu *et al*., 2014).

The Food and Agriculture Organization (FAO), established a classification system containing 30 soil groups from all over the world.

As part of Moldavian Plateau, Tutova Hills, with a surface of 3603 km^2 represents a distinct geographical unit in the Eastern part of Romania clearly bounded Westward and Eastward by two large valleys, Siret Valley and Bârlad Valley, that correspond to Siret and Bârlad Rivers. The benchmark soils from Tutova Hills (fig. 34), that comprise the Pereschiv basin (figures 13 and 16), were formed under specific conditions of relief, climate and vegetation of forest steppe from Eastern Romania. The main soil types in the Pereschiv basin (Niacşu, 2009), according to FAO (2001), are:

- Chernozems (WRB 2006): 40,62%,
- Luvisols (WRB 2006): 25,07%,
- Regosols and Leptosols (WRB 2006): 22,67%,
- Anthrosols (WRB 2006): 9,44%,
- Gleysols (WRB 2006): 0,88%,
- Solonetz (WRB 2006): 0,55%,
- Vertisols (WRB 2006): 0,33%

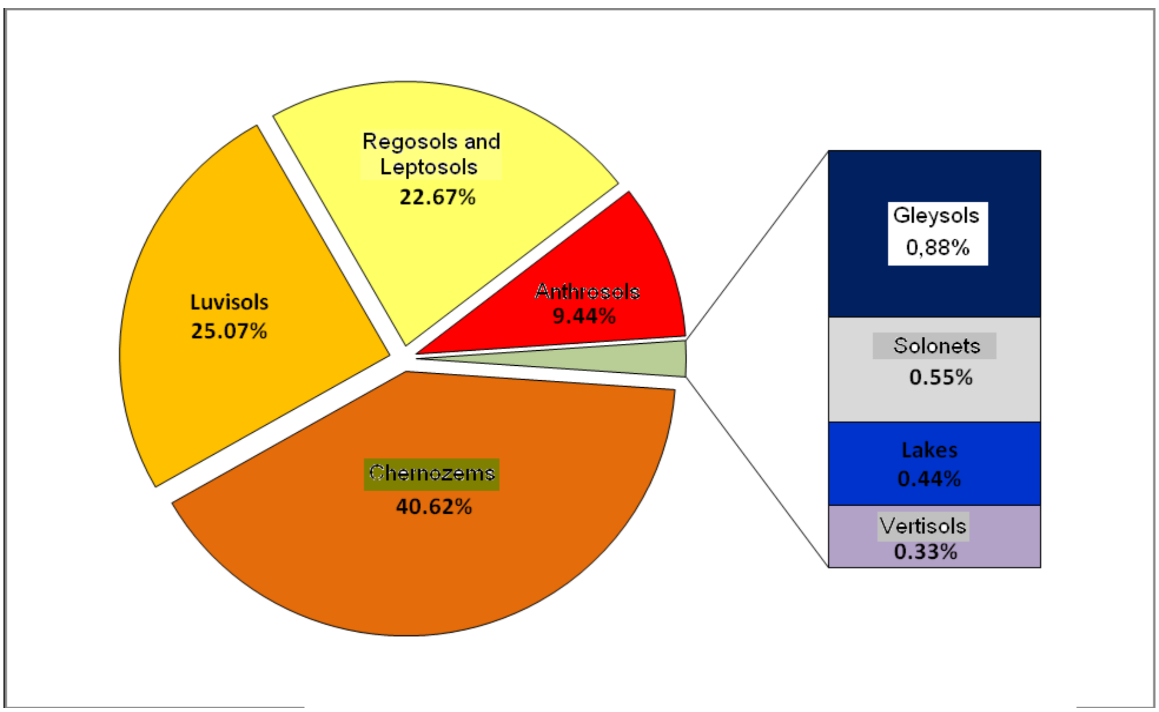


Figure 34. Classes of soils in the Pereschiv basin (after Niacsu, 2009)

Chernozems (coming from the russian words for “black earth”) are humus-rich grassland soils used extensively for growing cereals or for raising livestock.

They are found in the middle latitudes of both hemispheres, in zones commonly termed prairie in North America, pampa in Argentina, and steppe in Asia or in Eastern Europe. Chernozems account for 1,8 % of the total continental land area on Earth (Sposito, 2014 in Enciclopædia Britannica). Chernozems are characterized by a surface layer that is rich in humus and in available calcium ions bound to soil particles, resulting in a well-aggregated structure with abundant natural grass vegetation.

They form in climatic zones with seasonal rainfall of 450–600 mm (18–24 inches) per year, coming in the spring or early summer; with cold winters; and with relatively short, hot summers. In the colder areas of these climatic zones, a natural tall-grass vegetation develops on soil profiles whose surface layers can be as much as two metres (about six feet) thick, with up to 16 percent humus by mass. Lime may accumulate below this layer because of limited downward percolation of calcium salts.

The Reference Soil Group of the Chernozems (www.isric.org/major_soils_of_the_world/) accommodates soils with a thick black surface layer that is rich in organic matter.

Russian soil scientist Dokuchaev, coined the name “*Chernozems*” in 1883 to denote the typical “zonal” soil of the tall grass steppes in continental Russia.

Definition. Chernozems are soils that have:

- a mollic horizon (Am) like diagnostic horizon, with a moist chroma of 2 or less if the texture is finer than sandy loam, or less than 3.5 if the texture is sandy loam or coarser, both to a depth of at least 20 cm, or a mollic horizon which has these chromas directly below a plough layer;
- concentrations of secondary carbonates starting within 200 cm from the soil surface;
- no petrocalcic horizon between 25 and 100 cm from the soil surface;
- no secondary gypsum;
- no uncoated silt and sand grains on structural ped surfaces.

Connotation: black soils rich in organic matter; from russian chern - black, and zemlja - earth or land.

Parent material: mostly eolian and re-washed eolian sediments (loess).

Environment: regions with a continental climate with cold winters and hot summers; in flat to undulating plains with tall-grass vegetation (forest in the northern transitional zone).

Profile development: AhBC- profiles with a dark brown to black mollic surface horizon over a cambic or argic subsurface horizon; commonly with redistribution of calcium carbonate to a calcic horizon or pockets of secondary carbonates in the subsurface soil.

Fertility and use: the high natural fertility of Chernozems and their favourable topography permit a wide range of agricultural uses including arable cropping (with supplemental irrigation in dry summers) and cattle ranging. If the chernozems are long-term and intensive cultivated, they gradually diminishes the reserves of nutrients or damage its structure, with the entire ensemble of limitative factors (reducing porosity, permeability, water soil capacity, field capacity). Consequently, are necessary periodic organic and mineral (particularly with nitrogen and phosphorus) fertilization and adequate soil works (conservative and minimum tillage, soil loosening; preventing the crust formation) (Ianoş, 2004; Bireescu *et al.*, 2014).

Luvisols are characterized by mixed mineralogy, high nutrient content, and good drainage that make these soils suitable for a wide range of agriculture, from grains to orchards to vineyards. Luvisols form on flat or gently sloping landscapes under climatic regimes that range from cool temperate to warm Mediterranean. Occupying just over 5 % of the total continental land area on Earth, they are found typically in West-Central Russia, the United States, Central Europe, the Mediterranean basin, and Southern Australia.

Luvisols are technically characterized by a surface accumulation of humus overlying an extensively leached layer that is nearly devoid of clay and iron-bearing minerals. Below the latter lies a layer of mixed clay accumulation that has high levels of available nutrient ions comprising calcium, magnesium, sodium, or potassium.

The Reference Soil Group of the Luvisols (www.isric.org/major_soils_of_the_world/) holds soils whose dominant characteristic is a marked textural differentiation within the soil profile, with the surface horizon being depleted of clay and accumulation of clay in a subsurface “argic” horizon. Luvisols have high activity clays throughout and lack the abrupt textural change of Planosols, albeluvic tonguing as in Albeluvisols a mollic surface horizon as in steppe soils, ant the alic properties of Allisols. Definition: soils characterized by a visible textural differentiation (Idt > 1,2) and an argic (Bt) horizon, like diagnostic horizon, with a cation exchange capacity (in 1M NH_4O Ac at pH 7,0) equal or to greater than 24 cmol (+) kg^{-1} clay, either starting within 100 cm from the soil surface, or within 200 cm from the soil surface if the argic horizon is overlain by loamy sand or coarser textures throughout.

Connotation: soils in which clay is washed down from the surface soil to an accumulation horizon al some depth; the name of *luvisols* comes from “*luere*” (Latin): to wash, highlighting the eluviation of clay that was partially washed from the surface horizons profile, and their iluviation (accumulation) at the middle of the soil profile, in a representative argic horizon.

Parent material: a wide variety of unconsolidated materials including glacial till and eolian, alluvial and colluvial deposits.

Environment: most common in flat or gently sloping land in cool temperate regions and warm (e.g. Mediterranean) regions with distinct dry and wet seasons.

Profile development: ABtC – profiles; intergrades to Albeluvisols having an albic eluviation horizon above the argic, subsurface horizon are not rare. The wide range of parent materials and environmental conditions led to a great diversity of soils in the Reference Soil Group.

Fertility and Use: Luvisols have a moderated to reduced natural fertility due to their acidity, leaching of bases on the soil profile and nutrient deficiency in the upper layers of horizons (Ianoş, 2004; Bireescu *et al.*, 2014). Management of luvisols consists in: $CaCO_3$ amendment; organic and mineral fertilization.

Luvisols with a good internal drainage are potentially suitable for a wide range of agricultural uses because of their moderate stage of weathering and high base saturation.

Regosols are characterized by shallow, medium- to fine-textured, unconsolidated parent material that may be of alluvial origin and by the lack of a significant soil horizon (layer) formation because of dry or cold climatic conditions. Regosols occur mainly in polar and desert regions, occupying about 2 % of the continental land area on Earth, principally in northern China, Greenland, Antarctica, north-central Africa, the Middle East, and northwest Australia. They are usually found under their original natural vegetation or under limited dryland cropping.

Regosols often show accumulations of calcium carbonate or gypsum in hot, dry climatic zones. In very cold climatic zones they contain permafrost within two metres (about six feet) of the land surface. Regosols are similar to the soils in the Entisol order of the U.S. Soil Taxonomy that occur in either very cold or very dry and hot climatic zones.

The Reference Soil Group of the Regosols (www.isric.org/major_soils_of_the_world/) is a taxonomic rest group containing all soils that could not be accommodated in any of the other Reference Soil Groups. In practice, Regosols are very weakly developed mineral soils in unconsolidated materials that have only an ochric surface horizon and that are not very shallow

(Leptosols), sandy (Arenosols) or with fluvic properties (Fluvisols).

Definition: For all practical purposes, Regosols are soils in unconsolidated mineral material of some depth, excluding coarse textured materials and materials with fluvic proprieties. Regosols have not diagnostic horizons other than an ochric horizon. Connotation: soils in the weathered shell of the Earth; the name of *regosols* comes from "*rhegos*" (Greek): blanket, representing a thin layer of loose material over parent material, having the significance of thin and undifferentiated soils of the alteration crust (Florea *et al.*, 2005).

Parent material: unconsolidated, finely grained weathering material.

Environment: all climate zones without permafrost and al all elevations. Regosols are particularly common in arid areas, in the dry tropics and in mountain regions.

Profile development: AC – profiles with no other diagnostic horizon than an ochric surface horizon. Profile development is minimal as a consequence of young age and/or slow soil formation e.g. because of prolonged drought.

Fertility and use: the fertility of Regosols is very restricted, mainly by climatic and morphological conditions in spreading. Accordingly, their use and management vary widely. So, in the subtropical regions and steppes, on the accesible relief, some Regosols can be used as farming, but only under irrigations. Also, Regosols are occupied by forests and pastures with low quality (Ianoş, 2004; Bireescu *et al.*, 2014). Regosols in mountain areas are best left under forests.

Leptosols are soils with a very shallow profile depth (indicating little influence of soil-forming processes), and they often contain large amounts of gravel. They typically remain under natural vegetation, being especially susceptible to erosion, desiccation, or waterlogging, depending on climate and topography. Leptosols are approximately equally distributed among high mountain areas, deserts, and boreal or polar regions, where soil formation is limited by severe climatic conditions. They are the most extensive soil group worldwide, occupying about 13% of the total continental land area on Earth, principally in South America, Canada, the Sahara, the Middle East, central China, Europe, and Asia.

Because of continual wind or water erosion or shallow depth to hard bedrock, Leptosols show little or none of the horizonation, or layering, characteristic of other soils. Leptosols are related to the soils in the Entisol order of the U.S. Soil Taxonomy that are found in high mountains, deserts, or boreal and polar regions of the world. Regosols are a related FAO soil group originating from erosion processes.

The Reference Soil Group of the Leptosols (www.isric.org/major_soils_of_the_world/) accommodates very shallow soils over hard rock or highly calcareous material, but also deeper soils that are extremely gravelly and/or stony.

Definition: Leptosols are soils that have:

(1) continuous hard rock within 25 cm from the soil surface;

- a mollic horizon with a thickness between 10 and 25 cm directly overlying material with a calcium carbonate equivalent of more than 40% or,

- less than 10% (by weight) fine earth from the soil surface to a depth of 75 cm;

(2) having no diagnostic horizons other than a mollic, ochric, umbric or vermic horizon.

Connotation: shallow soils; the name of *leptosols* comes from Greek, "*leptos*": thin, respectively soils with a weak profile; "*leptic*" defines the presence of the hard rock in the first 25 cm.

Parent material: various kinds of rock or unconsolidated materials with less than 10% fine earth.

Environment: mostly land at high or medium altitude and with strongly dissected topography. Leptosols are found in all climatic zones, particularly in strongly eroding areas.

Profile development: A(B)R – or A(B)C- profiles with a thin A-horizon. Many Leptosols in calcareous weathering material have a mollic A-horizon that shows signs of intensive biological activity.

Fertility and use: the general fertility of Leptosols is very low. The main restriction is induced by the extremely small useful edaphic (physiologic) volume, as well as the low water retention capacity. For these reasons, Leptosols are not used in agriculture for annual crop production, but they manifests a some suitability for the wine-growing trees use and intensive grazing. The most productive Leptosols are spread in the wet climates, on the carbonated parent materials (Ianoş, 2004; Bireescu *et al.*, 2014). Leptosols are best kept under forests.

Anthrosols are defined as any soils that have been modified profoundly by human activities, including burial, partial removal, cutting and filling, waste disposal, manuring, and irrigated agriculture. These soils vary widely in their biological, chemical, and physical properties. Occupying 0,004 % of the continental land surface of the Earth, they are growing in extent along with the influence of human society on the soil environment.

The Reference Soil Group of the Anthrosols (www.isric.org/major_soils_of_the_world/)

comprises soils that were buried or profoundly modified through human activities such as addition of organic materials or household wastes, irrigation or cultivation.

Definition: Anthrosols are soils that have:

(1) a hortic, irragric, plaggic or terric horizon 50 cm or more thick; or

(2) an anthraquic horizon and an underlying hydragric with a combined thickness of 50 cm or more.

Connotation: soils with proeminent characteristics that result from human activities; the name of *anthrosols* comes from Greek, „*anthropos*": man: soil resulting from human activities.

Parent material: virtually any soil material, modified by man through cultivation or addition of material.

Environment: Plaggic Anthrosols in North-West Europe; Hydragric Anthrosols in Southeast and East Asia, and Irragric Anthrosols in the Middle East.

Profile development: influence of man is normally restricted to the surface horizon(s); the horizon differentiation of a buried soil can still be intact at some depth.

Fertility and use: the fertility of Anthrosols is varied, from unfertile to widely used farming, with increasingly better results, depending on climate conditions. European Anthrosols were traditionally grown to winter rye oats, and barley but are now also planted to forage crops, potatoes and horticultural crops; in places they a used for tree nurseries and pasture. Irragric Anthrosols occur in irrigation areas where they are under cash crops and/or food crops. Hydragric Anthrosols are associated with paddy rice cultivation whereas Hortic Anthrosols are (mainly) planted to vegetables for home consumption.

In term of management, their improving depends from one area to another, requiring intense fertilization and complex land use reclamation measures (Ianoş, 2004; Bireescu *et al.*, 2014).

Gleysols are formed under waterlogged conditions produced by rising groundwater. In the tropics and subtropics they are cultivated for rice or, after drainage, for field crops and trees. Gleysols found in the polar regions (Alaska and Arctic Asia; about half of all Gleysols) are frozen at shallow depth and are used only by wildlife. These soils occupy about 5,7% of the continental land area on Earth, including the Mississippi valley, north-central Argentina, central Africa, the Yangtze River valley, and Bangladesh.

Gleysols are technically characterized by both chemical and visual evidence of iron reduction. Subsequent downward translocation (migration) of the reduced iron in the soil profile is associated with gray or blue colours in subsurface horizons (layers). Wherever oxidation of translocated iron has occurred (in fissures and cracks that may dry out), red, yellow, or brown mottles may be seen. Gleysols are related to the Entisol and Inceptisol orders of the U.S. Soil Taxonomy, wherever the latter occur under waterlogged conditions sufficient to produce visual evidence of iron reduction. In warm climatic zones these soils occur in association with the FAO soil groups Fluvisol and Cambisol.

The Reference Soil Group of the Gleysols (www.isric.org/major_soils_of_the_world/) holds wetland soils that, unless drained, are saturated with groundwater for long enough periods to develop a characteristic "*gleyc colour pattern*", essentially made up of reddish, brownish or yellowish colours at ped surface and/or in upper soil layer(s), in combination with greyish / bluish colours inside the peds and/or deeper in the soil.

Definition: Gleysols are soils:

(1) having gleyc properties within 50 cm from the soil surface;

(2) having no diagnostic horizons other than an anthraquic, histic, mollic, ochric, takyric, umbric, andic, calcic, cambic, gypsic, plinthic, salic, sulfuric or vitric horizon within 100 cm from the soil surface;

(3) having no abrupt textural change within 100 cm from the soil surface. Connotation: soils with clear signs of excess wetness; the name of *gleysols* comes from Russian, „*gley*": mucky mass.

Parent material: a wide range of unconsolidated materials, mainly fluvial, marine and lacustrine sediments of Pleistocene or Holocene age, with basic to acidic mineralogy.

Environment: depression areas and low landscape positions with shallow groundwater.

Profile development: mostly A(Bg)Cr – or H(Bg)Cr- profile. Evidence of reduction processes with or without segregation of iron compounds within 50 cm of the surface.

Fertility and use: Gleysols have a medium to low fertility due to deficient air-water regime (Ianoş, 2004; Bireescu *et al.*, 2014). For this reason, Gleysols are mainly occupied by swamp vegetation, meadows and pastures, and lie idle or are used for extensive grazing. Artificially drained Gleysols are used for arable cropping, dairy farming and horticulture. Gleysols in the tropics and subtropics are widely planted to rice.

In term of management, their improving requires strong measures to remove the excess water by deep drainage works, loosening and amendments or fertilizer application according to their chemical proprieties (Ianoş, 2004; Bireescu *et al.*, 2014).

Solonetz soils are defined by an accumulation of sodium salts and readily displaceable sodium ions bound to soil particles in a layer below the surface horizon (uppermost layer). This subsurface layer also contains a significant amount of accumulated clay. Because of the high sodium content and dense, clay-rich subsoil, irrigated agriculture of these soils requires extensive reclamation—through leaching with fresh water and the construction of engineered drainage systems. Occupying about 1 percent of the continental land area on Earth (northeastern Argentina, Chile, and the coastal edges of every continent), Solonetz soils occur in dry climatic zones and on parent materials either naturally enriched in sodium-bearing minerals or influenced by saline waters.

Solonetz are related to the sodium-accumulating Aridisols and Mollisols of the U.S. Soil Taxonomy. Because they do not require a warm climate in order to form, they can be found in association with both Solonchaks and Kastanozems, two FAO soil groups that form in warm and temperate climatic zones, respectively.

The Reference Soil Group of the Solonetz (www.isric.org/major_soils_of_the_world/) accommodates soils with a dense, strongly structured, clayey subsurface horizon that has a high proportion of adsorbed sodium and/or magnesium ions.

Definition: Solonetz are soils that have a natric horizon within 100 cm from the soil surface.

Connotation: soils with a high content of exchangeable sodium and/or magnesium ions; the name of *solonetz* comes from two russian words: "*sol"*: salt and "*etz"*: strongly expressed, highlighting a high percentage of exchangeable sodium and alkaline pH.

Parent material: unconsolidated materials, mostly fine-textured sediments.

Environment: Solonetz a normally associated with float lands in a climate with hot, dry summers, or with (former) coastal deposits that contain a high proportion of sodium ions. Major concentrations of Solonetz are in flat or gently sloping grasslands with loess / loam or clay in semi-arid, temperate and subtropical regions.

Profile development: AbtnC - and AEBtnC - profiles with a black or brown surface soil over a natric horizon that starts at less than 100 cm from the soil surface. Well-developed Solonetz can have a (begining) albic eluviation horizon directly over a natric horizon with strong round-topped columnar structure elements. A calcic or gypsic horizon may be present below the natric horizon. Many Solonetz have a field-pH around 8,5 indicative of the presence of free sodium carbonate.

Fertility and use: usually, Solonetz are not used as arable in terms of unimproved status, because they are very poor in nutrients, have alkaline pH and high concentrations of sodium (Ianoş, 2004; Bireescu *et al.*, 2014). Accordingly, high levels of exchangeable sodium ions affect arable cropping, either directly leading to Na-toxicity or indirectly, e.g. because of structure deterioration when soil material with high proportion of adsorbed sodium and/or magnesium ions is wetted. Many Solonetz in temperate regions have a humus-rich surface soil and can (still) be used for arable farming or grazing. In semi-arid regions, Solonetz are mostly used as range land or lie idle.

In term of management, in some regions of the earth, Solonetz are improved by deep plowing (1 meter or more) to bring the gypsic horizon to surface. Being poorly supplied with nutrients, are necessary organic-mineral fertilization (Ianoş, 2004; Bireescu *et al.*, 2014).

Vertisols are characterized by a clay-size-particle content of 30% or more by mass in all horizons (layers) of the upper half-metre of the soil profile, by cracks at least 1 cm (0,4 inch) wide extending downward from the land surface, and by evidence of strong vertical mixing of the soil particles over many periods of wetting and drying. They are found typically on level or mildly sloping topography in climatic zones that have distinct wet and dry seasons. Vertisols contain high levels of plant nutrients, but, owing to their high clay content, they are not well suited to cultivation without painstaking management. They are estimated to occupy about 2,7% of the continental land area on Earth, mainly in the Deccan Plateau of India, the Al-Jazīrah region of The Sudan, eastern Australia, Texas in the United States, and the Paraná basin of South America.

Vertisols are dark-coloured soils (though they have only moderate humus content) that may also be characterized by salinity and well-defined layers of calcium carbonate or gypsum. Vertisols are churning heavy clay soils with a high proportion of swelling clays (www.isric.org/major_soils_of_the_world/). These soils from deep wide cracks from the surface downward when they dry out, which happens in most years.

Definition: Vertisols are soils having:

(1) a vertic horizon within 100 cm from the soil surface;

(2) after the upper 20 cm have been mixed, 30% or more clay in all horizons to a depth of 100 cm or more, or to a contrasting layer (lithic or paralithic contact, petrocalcic, petroduric or petrogypsic horizons, sedimentary discontinuity, etc.) between 50 and 100 cm;

(3) cracks, which open and close periodically.

A crack is an open space between gross polyhedrons. Cracks may be filled mainly by granular materials from the soil surface but remain open in the sense that the polyhedrons are separated.

Connotation: churning heavy clay soils; the name of *vertisols* comes from latin "*vertere*": to turn, rotation, movement, suggesting that in the soil profile there is a movement, a continue return and mixing horizons in the first 25-100 cm from the surface.

Parent material: sediments that contain a high proportion of smectite clay, or products of rock weathering that have the characteristics of smectite clay.

Environment: depressions and level to undulating areas, mainly in tropical, semi-arid to (sub)humid and Mediterranean climates with an alternation of distinct wet and dry seasons. The climax vegetation is savanna, natural grassland and/or woodland.

Profile development: A(B)C-profiles. Alternate swelling and shrinking of expanding clay results in deep cracks during the dry season, and formation of “slickenside” and wedge-shaped structural elements in the subsurface soil.

Fertility and use: Vertisols have disadvantages in applying agricultural technologies, due to the high content of clay, being very hard in the dry season and sticky in the wet season. For this reason, in Romania, they called “*soils of one day*” (Ianoş, 2004; Bireescu *et al.*, 2014). Although, deficiencies induced by the restrictive physical properties (mainly high bulk density, around 1,7-2 g/cm^3) Vertisols are the most fertile soils in the tropical regions, being used for the cotton, wheat, barley and sugar cane crops. Although they have a relatively high capacity for water retention, the plants with a superficial root system can suffer because of drought.

Vertisols raise serious problems in terms of buildings (cracking foundations and walls), hydro-ameliorations (destructions of pipes, roads), agriculture (breaking the roots of plants).

In term of management, for an optimal use are recommended sprinkler irrigations with low doses of water repeated at short intervals (Ianoş, 2004; Bireescu *et al.*, 2014).

6.2. Benchmarck soils in the Pereschiv basin

We performed two soil profiles in the Southern Pereschiv basin (Figure 35).

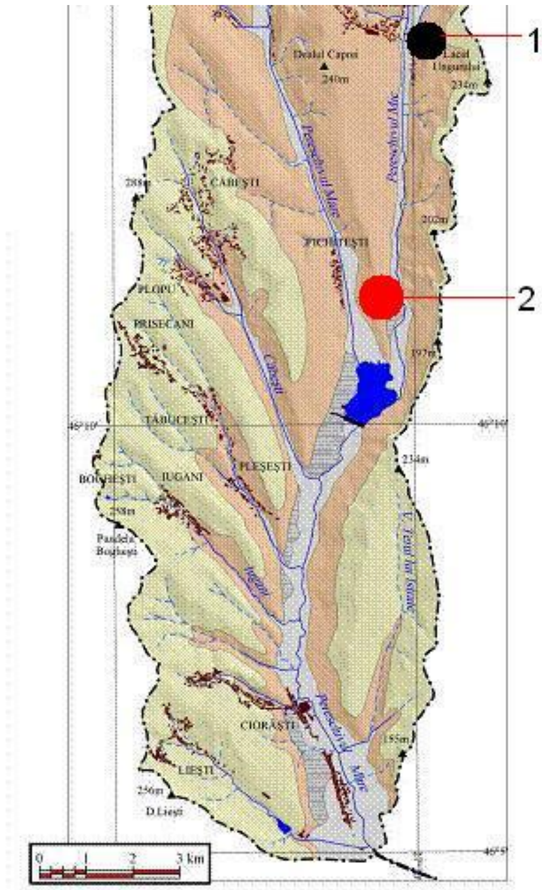


Figure 35. The soil profiles (1 and 2), pointed on map

First profile was made near the left slope of the river Pereschiv, in the lower third, South-East of Căbeşti village, Bacău county (Figure 36 a, b, c d). The location was 46° 10’ 96” lat N and 27° 29’ 85” long E. Altitude 94 m, upstream of Fichiteşti lake, western exposition, with a slope (incline) of 15-20°. Alluvial plain, meadow vegetation with reed, willow, poplar, hygrophile natural vegetation and *Helianthus angustifolia* expanded from the plantation nearby. Parental material clayey delluvium. Usage for grazing, degraded pasture (grassland). Depth 0-4 Top layer, 4-16 A, 16-32 AC, 32-50 C_1, over 50 C_2.

Soil with no significant profile development - Calcaric Leptic Regosols (Figure 36 a); Details of soil thatch layer (Figure 36 b); Local accumulation of calcium carbonate (Figure 36 c) and Details of calcium carbonate accumulation (Figure 36 d).

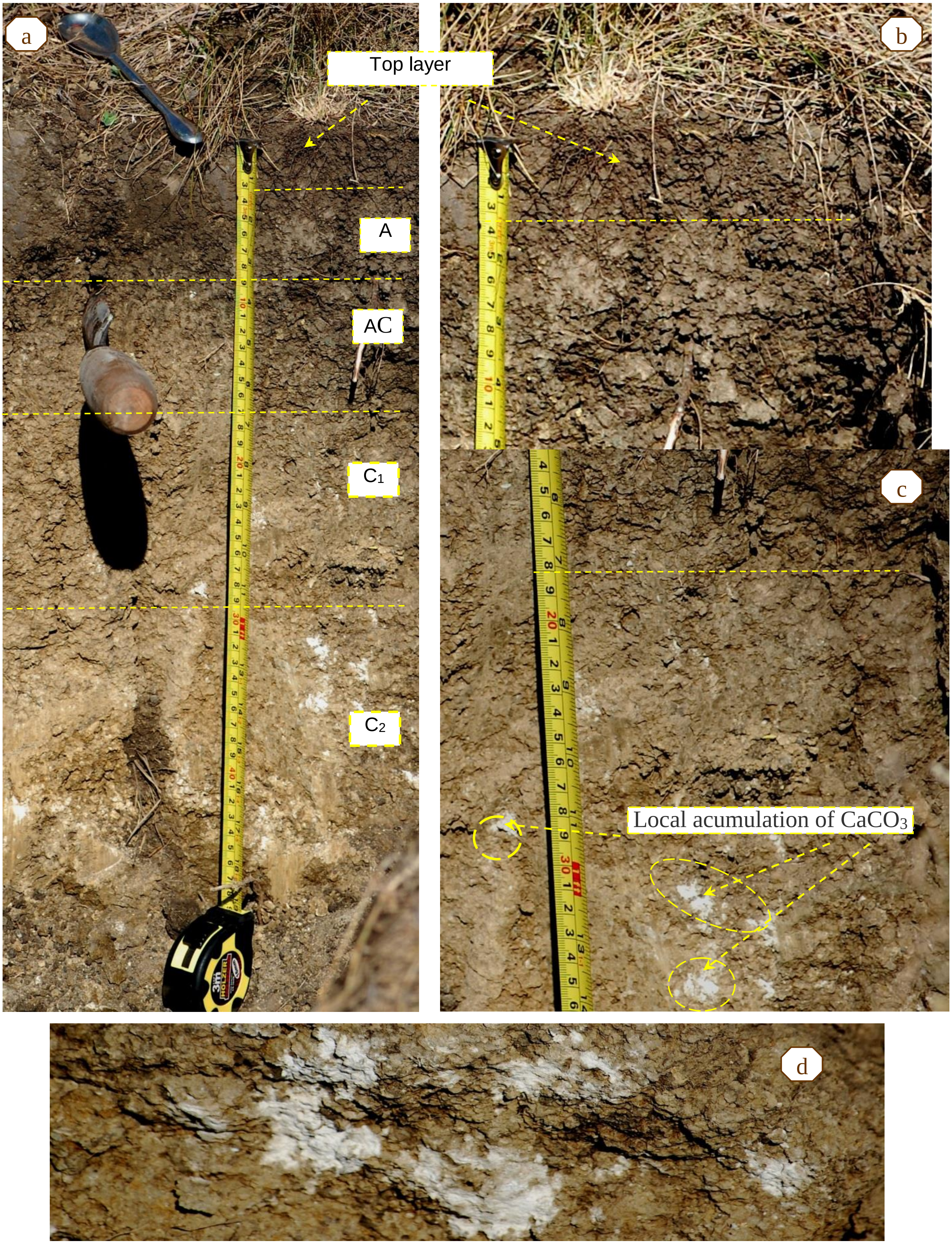


Figure 36. Soil profile, South-East of Căbeşti village, Bacău, Pereschiv basin

The second profile was in Bacău county, East of Fichiteşti lake (Figure 37).

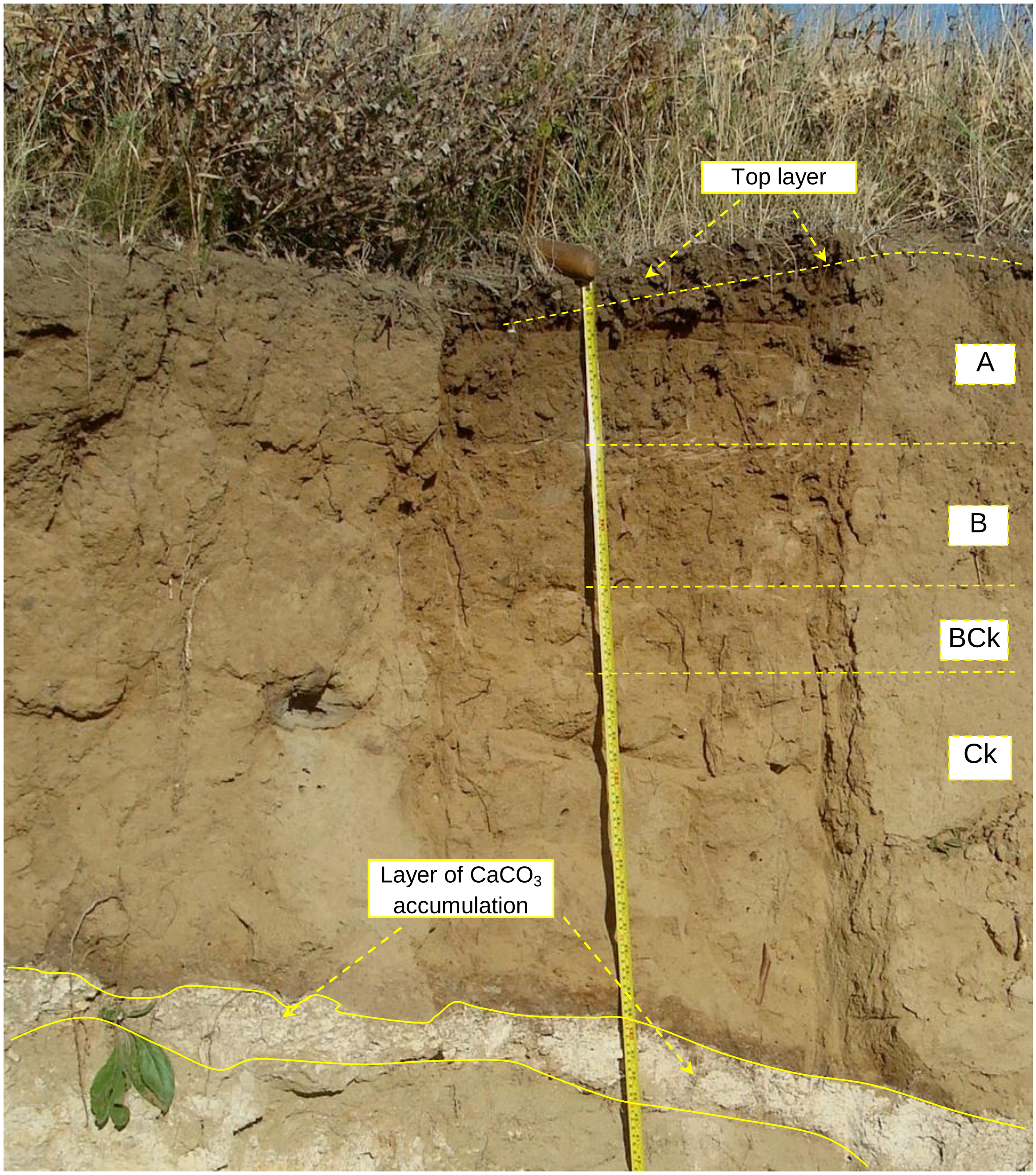


Figure 37. Soil profile, East of Fichiteşti lake, Bacău

The location was 46° 13’ 45” lat N and 27° 30’ 11” long E. Figure 37 represents *Eutric ochric Cambisols* (B - cambic horizon; BC – transition soil horizon; k – presence of $CaCO_3$; A – humic ochric horizon).

Eutric ochric Cambisols is located on the upper third of moderately soped land, with Western-South-East exposition on the altitude of 198 m. The soil is the beginnings of horizon differentiation. A slight humus accumulation on the upper part of soil profile (A horizon) is evidentiated by light brown colour. The B horizon is developed after leaching of calcium carbonate and changes in colour and structure. The *Eutric ochric Cambisols* formation is favored by relative dry climate (500 mm), by high water permeability and by active geologic erosion. Moderate eroded soil, on maeotian sands, diluvial deposits. Parental material diluvium on maeotian sands. Usage for grazing, ruderalised degraded pasture. General slope 10-15°. Depth 0-8 Top layer, 8-20 A, 20-32 B, 38-55 BCk, 55-86 Ck, 89-90 blacky layer of Fe and Mn oxydes, 90-98 carbonate layer. All over we could see neoformations of roots, krotovina.

6.3. Ecological interpretation of soil

Ecological study of soil as a living environment of plants in natural and cultivated terrestrial ecosystems, is considered today as a major necessity worldwide. Ecological interpretation of the soil (Chiriţă, 1974; Bireescu et al., 2010) is absolutely necessary because soil fertility is influenced positively or negatively by **ecological factors** and **determinants**. The unitary and integrated ecological study of soil, allows the establishing of a multilateral complex of attributes and processes which influences the plant growth. The productive potential of soil manifests by lack or excess of the value of these parameters. The pedo-ecological researches followed soil study both in the field (soil profiles) as well in the laboratory (analysis after standard methodology). They were identified 20 main climatic and pedological zonal and local factors and determinants, which we analyzed in ecological data sheet, and ecological impact matrix (global, zonal and local). The 20 factors and ecological determinants were categorized into 8 classes of ecological size in terms of quantity and 6 classes of ecological favorability in terms of quality. The factors influence directly soil and plant nutrition, but the determinants has an indirectly influence. These factors and determinants are:

- 5 climatic ecological factors (*average annual temperature*, *average annual rainfall*, *wind regime*, *the average summer rainfall*, air *relative humidity in summer*);
- 3 pedological growth factors (*total nitrogen content, the content of mobile phosphorus, assimilable potassium content*);
- 2 pedological factors space and time condition (*useful edaphic volume, bioactive period length*);

- 2 negative pedological factors in lack or excess (summer consistency, alkality/acidity);

- 8 pedological determinants (*soil reaction, humus content, base saturation, base exchange amount, total cation exchange capacity, biological activity, soil aeration, a synthetic index of potential soil trophicity*).

6. 4. The influence of pedomesofauna on soil quality in Tutova Hills

Terrestrial and soil organisms that cover 94% of living species (National Academy Press, 1992, cited by Paoletti *and* Bressan, 1996) can offer a consistent opportunity for environmental evaluation. The soil provides a living place for the life cycle of several kind of animals. Invertebrates, in particular, play a significant role in the maintenance of soil quality and health, and therefore represent key elements for a sustainable agriculture. Organic matter decomposition is greatly facilitated by mites, earthworms and termites. Also, nutrient cycling, closely associated with organic matter decomposition, is determined by protozoa and nematodes. Ants, termites, earthworms and other soil macro-fauna create channels, pores, aggregates and mounds that profoundly influence the transport of gases and water in soil, modifying also the microhabitats for other soil organisms (Santorufo *et al.*, 2012). Soil invertebrates mix organic and the inorganic components, changing the microstructure of the soil, which in turn drives the complex processes of microbial succession (the process by which a plant or animal communities change over time) (Verma *and* Paliwal, 2010). In addition, the invertebrates are abundant, relatively easy to sample, and they can quickly respond to soil disturbance (McIntyre *et al.*, 2001), being considered valuable indicators of soil disturbances (Nahmani *and* Lavelle, 2002; Santorufo *et al.*, 2012). For all these reasons, the soil invertebrates are considered valuable indicators of soil quality.

According to literature (Dazzi *et al.*, 2002; Hawksworth *and* Ritchie 1993; McGeoch, 1998) pedomesofauna can been used as bioindicators for soil quality. Human management of soils, particularly in agricultural fields, has shown a decrease of the richness of arthropod species, being a major cause of community depletions. Many arthropods prefer undisturbed areas because of the abundance of plant biomass that can be fully utilized (Hooper, *et al.*, 2000). It has also been suggested that the amount of vegetation cover can be an essential factor that contributes to the species composition (Pinzari *et al*., 2001)

Hammond (1990) found that 25% of beetle fauna was associated with the soil/leaf litter for the feeding part of their life cycle. Of the British insect fauna, probably 10% of the 22,000 species are closely associated with the soil and leaf litter, and possibly another 15% are loosely associated (e.g., many Lepidoptera pupate in the soil).

Isopods also may move litter deeper into the soil (Hassall *et al*., 1987). The soil structure and therefore many of its features that contribute to soil fertility, is largely determined directly (topsoil) or indirectly (mineral soil) by invertebrate fecal dynamics (Pawluk, 1985; Rusek, 1985). For example, invertebrate fecal material was a significant component of all surface layers rich in organic matter in all regions of Canada (Pawluk, 1987). Decaying invertebrates may also contribute to nitrogen mineralization of the soil (Abrahamsen, 1990).

Regarding the groups of invertebrates found into the soil, we highlight those which contributes more to the soil quality.

Generally soil fauna is subdivided as follows (Anderson, 1988a):

• *Microfauna.* These are invertebrates of less than 100 µm, mostly nematodes. Nematodes are associated with water films (2 to 5 µm thick) on the surface of soil and organic particles, and water filled pores (20 µm wide).

• *Mesofauna.* This diverse group of invertebrates is of sufficient size to overcome the surface tension of water on soil particles but are not enough large to disrupt the soil structure in their movement through soil pores (body width between 100 µm and 2 mm). They include Acari (mites), Collembola (springtails), enchytraeid worms, small Diplopoda (millipedes), and many small larval and adult insects. Studies of the mesofauna have concentrated on springtails and mites. Soil mites could be used as bio indicators for ecotoxicolgical responses and environmental monitoring (Khalil *et al.,* 1999). Many species of mesofauna are mycophagous and therefore affect fungal populations strongly.

• *Macrofauna.* This group consists of species enough large to disrupt the soil by their burrowing and feeding (2 mm to 20 mm wide). The most important taxa are Isopoda (woodlice), larger Diplopoda, earthworms, Isoptera (termites), Coleoptera (beetles), Diptera (flies), ants, and mollusca.

All three groups have a complex role in influencing soil quality. In general, the roles of micro- and mesofauna are enhancing microbial activity (Wright *et al*., 1989), accelerating decomposition (Christiansen *et al*., 1989; Setala *et al*., 1988) and mediating O.M. evolution in the soil (Anderson, 1988b). Collembola, earthworms, nematodes, and mites are particularly important.

Collembola (Springtails). Soil-dwelling springtails decompose plant residues (Kiss *and* Jager, 1987; Takeda, 1988). Larger species increases mineralization by selective feeding on fungi,

while smaller species help in soil humification by non-selective scavenging and by mixing organic material and mineral soil particles (van Amelsvoort *et al*., 1988).
Low levels of Collembola stimulate both, fungal and bacterial growth, but higher levels may negatively affect fungal populations and reduce humification of the soil (Hanlon *and* Anderson, 1979).

Earthworms contribute, both, to the bioturbation of the soil by the mixing of soil particles from the surface to lower layers and vice versa, and to the water balance. In temperate regions, earthworms have a major contribution to soil structure, and thus to soil community stability and soil quality (Stork *and* Eggleton, 1992). Earthworm activity aerates and mixes the soil. Studies have shown that the inoculation of earthworms in the poor soils leads to increases in the plant yields (Edwards *and* Bater, 1992). The major benefits of earthworm activities to soil fertility can be summarized as:

■ Biological: In many soils, earthworms play a major role in the conversion of large pieces of organic matter into rich humus, improving soil fertility. This is achieved by the worm's actions of pulling below the surface, deposited organic matter such as leaf fall or manure, either for food or to plug its burrow. Once in the burrow, the worm will shred the leaf and partially digest it and mingle it with the earth (Nyle *and* Weil, 2009).

■ Chemical: In addition to dead organic matter, the earthworm also ingests any other soil particles that are enough small, including sand grains up to 1/20 of an inch (1.25 mm), into its gizzard, wherein those minute fragments of grit grind everything into a fine paste which is then digested in the intestine. The worm excretes this in the form of casts, which are deposited on the surface or deeper in the soil. Thus, minerals and plant nutrients are changed to an accessible form for plants to use. Investigations in the United States show that fresh earthworm casts are five times richer in available nitrogen, seven times richer in available phosphates, and 11 times richer in available potassium than the surrounding soil (Nyle *and* Weil, 2009).

■ Physical: The earthworm's burrowing creates a multitude of channels through the soil, an essential element of the soil pore system. These channels are very important in maintaining the soil structure, enabling processes of aeration and drainage. Permaculture co-founder Bill Mollison points out that by sliding in their tunnels, earthworms "act as an innumerable army of pistons pumping air in and out of the soils on a 24-hour cycle (more rapidly at night)" (Mollison, 1988). Thus, the earthworm not only creates passages for air and water to traverse the soil, but also modifies the vital organic component that makes a soil healthy. Earthworms promote the formation of nutrient-rich casts that have high role in the soil aggregation and soil fertility and quality (Nyle *and* Weil, 2009). Where earthworms are not present, dense mats of dead or decaying root material can build up at the soil surface, locking up nutrients. Earthworms also reduce soil crushing after heavy rainfall (Kladivko *et al*., 1986).

Nematodes. 90% of nematodes reside in the first 15 cm of soil. Nematodes do not decompose organic matter, but are parasitic and free-living organisms that feed on living material. Nematodes can effectively regulate bacterial population and community composition - they may eat up to 5.000 bacteria per minute (Nyle *and* Weil, 2009). An important feature of nematodes is that they can enter cryptobiotic states and thus track temporal changes in microbial levels. Nematode populations are affected by soil structure. Population growth is lower in fine textured soil than in coarse textured soil (Elliott *et al*., 1980). Nematodes are strongly influenced by their microenvironment and vary in sensitivity to pollutants and environmental disturbance. Application of nematode faunal composition analysis provides information on succession and changes in decomposition pathways in the soil food-web, nutrient status and soil fertility, acidity, and the effects of soil contaminants, offering an useful reflection of soil health status and several soil functions (Mulder *et al*., 2005; Sánchez-Moreno *et al.*, 2006).

Mites (Acari). The major positive contribution of the Acari in soils is their role in the decomposer subsystem. Mites are important in the soil as fungivores, bacteriovores and nematode predators (Largerlof *and* Andren, 1988). They also are important in fragmenting litter, dispersing microbial spores, and stimulating the activity of soil microflora.

In the 1996-1998 period, in Tutova Hills (Moldavian Plateau) from Eastern Romania, were accomplished several researches on mesofauna in the soils of deciduous forests, from this geographical unit, named hornbeam beech forests and hornbeam-common oak forests, both, typical and mixed with lime.

If in the case of hornbeam beech forest, the analysis included only the gamasids population (Călugăr *and* Huțu, 1999), the assessment of the biodiversity of soil micro-artropods in the oak forest with hornbeam was achieved also through the appreciation of the taxonomic diversity of mites, that belong to the order of Oribatida and sub-order of Gamasina Leach, 1815 (Vasiliu *et al.*, unpublished data). Thus, here was made the inventory and overall analysis of the four orders of mites (*Gamasida, Oribatida, Actinedida, Acaridida*), of an order belonging to the Insecta (*Collembola*) class and, overall, other groups of insects and soil micro-artropods (pseudoscorpions, centipedes etc.). The study accomplished in the hornbeam-common oak forests from Tutova Hills also comprised the coenological analysis of the oribatid an gamasid communities.

Fauna of gamasids in the investigated forestry ecosistems was represented by a number of 94 species, of which 11 belonged to *Uropodina* Kramer, 1888 sub-order and 83 species to *Gamasina* Leach, 1815 sub-order. In terms of quantity, the examination of global average densities of the soil gamasid populations showed values between 600 individuals/m^2 and 2230 individuals/m^2, the both values being identified in the hornbeam-common oak forests with lime, the lowest values in the haplic luvisol (WRB, 2006; brun argilo-iluvial-RSST, 2003), and the highest values in the distric luvisol (WRB, 2006; brun luvic-RSST, 2003).

Fauna of oribatids in the hornbeam-common oak forests summed up a total of 77 species, with global average densities between 7600 individuals/m^2 and 19680 individuals/m^2, the oribatids being the most important, both, in number of species and individuals within the soil fauna of mites. The extreme values of global average density were observed in the hornbeam-common oak forests with lime, on the haplic luvisol (WRB, 2006; brun argilo-iluvial-RSST, 2003), like in the case of gamasids.

In terms of the environmental exigency of the two representative groups of mites have been found that the species with high ecological plasticity are the most numerous, followed by the indifferent species in relation to the vegetation and then, by forestry species. Zoo-geographical analysis showed the dominance of European species, with an important percentage of the South European species, followed by the holarctic and then by the cosmopolitan species.

The studied comunities of soil micro-arthropods reflect, both, the characteristics of the stations and the complex changes produced by anthropogenic impact in this area, particularly deforestations that has destroyed the mountain status of the forestry ecosystems and led to the arid climate.

7
Socio-economical study and living standard of the population in the studied area

7. 1. Socio-economical aspects

Tutova Hills is a geographical unit which poses serious organizational and socio-economical problems. Tutova Hills fall among the least developed ecological areas of Romania, with a high degree of repulsiveness and thus an increased vulnerability of human structures. On this background, in recent times, Tutova Hills has been (almost without exception) ignored by governmental authorities and permanently avoided by the investors, making infeasible and very hard to apply any plans for overall sustainable development of the region. More suitable seems to be the identification of weak points and helping local or regional authorities to intervene on them, allowing at the same time a step by step development, by national and European investment programs.

In terms of demographic, due to permanent migration, there is a continuous decrease of rural population with high index of feminization and aging or de-professionalization.

Territorial organization highlights several problems due to the large number of small and isolated villages, or unfavorable geomorphologic and climatic conditions. Investment is needed to arrange slopes and irrigation systems, vital for intensive high yield farming, which together with socio-economic development, stop the migration of the population and reduced labor potential, an important factor of raising the life standard.

Human communities in Tutova Hills have experienced different hazards, natural or human-induced ones, the impact being more and more significant in the two last decades. These hazards are closely linked to the major changes of Romanian rural society in post-communist era. According to the National and Regional Strategy (for the period 2013-2020) and considering that Tutova Hills is an agricultural region, the main hazards are related to climate processes, affecting the vital resources of peoples, both, by excessive droughts, hail and heavy rains and by blizzard isolating entire villages in winter.

In terms of human geography, Tutova Hills represents an **exclusively rural** region with a low degree of accessibility and aged population, generally isolated in small villages, without any infrastructure or technical urban facilities, as it highlights in the figure 38.

Figure 38. Road between the small communities from Tutova Hills, Romania

There are 412 villages, mostly of dissociated type, with about 203 300 inhabitants, more than 90% of the active population being involved in agricultural activities. The agriculture, dominated by crop production (wheat, rye, sun flower, potatoes, corn, vegetables), is characterized by the existence of small plots (often of less than one hectare), insufficient mechanization and ignoring the ecological, agro-technical or economic principles. There are small plots that cannot be maintained by anti-erosion works. The soil works are made from top to the base, aggravating the erosion processes, by anthropogenic technological impact.

Droughts are the most frequent natural extreme phenomena in the region, affecting the water resources and crop production almost every year, having catastrophic consequences once every four or five years. The 2007 year is the most recent example, with excessive drought that exhausted water resources, field crops and even natural vegetation. Consequently, many villages have remained without drinking water or food supply, the effect being almost dramatic in the next winter (Stângă, 2009).

Hail and heavy rains act rather locally at one time but at least one event occurs once a year in the summer season all over the entire region, affecting crop yields and causing serious damages, with serious economical consequences. Furthermore, heavy rains exacerbate gully erosion that cause enormous soil losses on slopes (Ioniţă, 2007), dropping the productivity and forcing the farmers to abandon their plots on sloping lands, as it highlights in the figures 39, 40 and 41.

Fig. 39 Example of gully erosion in Tutova Hills

Fig. 40 Example of environmental degradation in Tutova Hills (general view)

Fig. 41 Example of environmental degradation in Tutova Hills (details)

Besides, in the last 20 years in Romania, particularly in the Eastern part, unreasonable, uncontrolled and aggressive actions of the anthropogenic factors corroborated with soil water erosion, accentuated the processes of environmental degradation and decreased the productive potential of the pedosystems. The erosion phenomena in the Eastern part of Romania are very aggressive, this area being considered one of the most active in Romania in terms of geomorphologic processes. The main geomorphologic process is represented by active processes of the slope fluvial-torrential nature. The temperate climate with torrential rainfalls together with the negative anthropogenic impact, due mainly to intensive grazing, amplifies and aggravates the degradation processes and phenomena, as it highlights in the figures 42 a, b and c.

a b C

Figure 42. Example of degradation by anthropogenic impact in Tutova Hills - intensive grazing

A blizzard occurs every year, especially in January or February, isolating and/or leaving many villages without utilities and supplies, for several days or even one or two weeks. An example of this is highlighted by the winter of 2011 and 2012, particularly the end of January and full February.

Human-induced hazards like accidental fires in dwellings or household annexes etc. have a lower frequency, but each time they occur. The impact is related to the reduced capacity of society to cope with disaster.

Vaslui county, especially the Tutova Hills region is considered one of the poorest human communities in Romania. It is also considered the pole of poverty in the European Union. The villages in this area are not up to date with technology, infrastructure (Figure 38), electricity, canalization, water supplies, construction materials, access to education.

7. 1. 1. Uni-dimensional versus multi-dimensional poverty

The standard of living, and therefore poverty, may be represented by a uni-dimensional approach (like income, monetary indicator) or a multi-dimensional approach (like income, health conditions, family status, etc). In the first case, poverty is defined by income poverty and the standard of living is defined in the space of economic welfare, a narrower concept than well-being. In the second case, the concept of poverty is closer to well-being, where other welfare indicators support income in defining (Sen, 1985).

I think that in Tutova Hills, both, uni-dimensional and multi-dimensional approaches should be taken into consideration due to the feedback established between them.

I have identified some problems in the rural development of investigated area, such as:

1. In the 21st Century, there is no electricity supply and infrastructure in many villages. Also, there is no gas, sewerage, running water at all.

2. Many rural people use primitive methods of cooking, living and farming and they trust in these methods.

3. Population living in rural areas has very little employment opportunities.

4. Literacy is still a problem in rural development.

5. Everyone wants to live in the cities, so that rural population is ignored by the policy makers also. On the other hand, the young families leave to work abroad, due to higher opportunities for jobs and decent living standard, establishing there.

6. Policy makes policies, programmes for rural people but, if these programmes are not in accord with the living standard, with the needs of population, they will be unuseful.

7. Privatization concept is useful for rural development but, the government not paying much attention to this aspect.

7. 2. Living standard and negative factors like wrong land use, alcohol, land restitution

In Tutova Hills, the local people are still supplied with water from wells (figure 43).

Figure 43. Wells as water supply for the population from Tutova Hills, Romania

In figure 44, we can see a woman collecting pieces of clay as construction material. This reflects a level of extreme poverty.

Figure 44. Local woman collecting clay as construction material, Tutova Hills, Romania

Clay was used to build houses in the XIXth century, but the population living in the investigated area, still use the clay as construction material, to build homes or annexes or to improve or to repair their homes. Although we are in the 21st century, the population still lives like in the XIXth Century conditions (Figure 45).

Figure 45. Example of a home in Tutova Hills, Romania

The total population in the Southern part of Pereschiv basin is 10 929 inhabitants (Table 23).

- Podu Turcului (Bacău) commune has 4617 inhabitants,
- Bogheşti (Vrancea) commune has 1680 inhabitants,
- Iveşti (Vaslui) commune has 2409 inhabitants and
- Priponeşti (Galaţi) commune has 2223 inhabitants, according to the Population Census in 2011.

Table 23. The repartition of population in communes and villages
(after National Population Census, 2011)

Commune	Village	Number of inhabitants	Total inhabitants/ commune
Podu Turcului (Bacău county)	Podu Turcului	2569	**4617**
	Bălăneşti	167	
	Căbeşti	694	
	Fichiteşti	100	
	Giurgioana	98	
	Hanţa	53	
	Lehancea	253	
	Plopu	157	
	Răcuşana	51	

	Sârbi	475	
Priponesti (Galaţi county)	Priponeşti	450	**2223**
	Ciorăşti	1046	
	Lieşti	232	
	Priponeştii de Jos	495	
Ivesti (Vaslui county)	Iveşti	2409	**2409**
Boghesti (Vrancea county)	Bogheşti	345	**1680**
	Bicheşti	190	
	Bogheştii de Sus	151	
	Chiţcani	143	
	Iugani	185	
	Plăcinteni	216	
	Pleşeşti	107	
	Prisecani	251	
	Tăbuceşti	92	
Total Inhabitants in the studied area			**10 929**

In the 2002-2011 period, from the previous Population Census (2002), the population in this area decreased by 1518 inhabitants (Table 24). It is considered a high decrease, of 12% in only nine years.

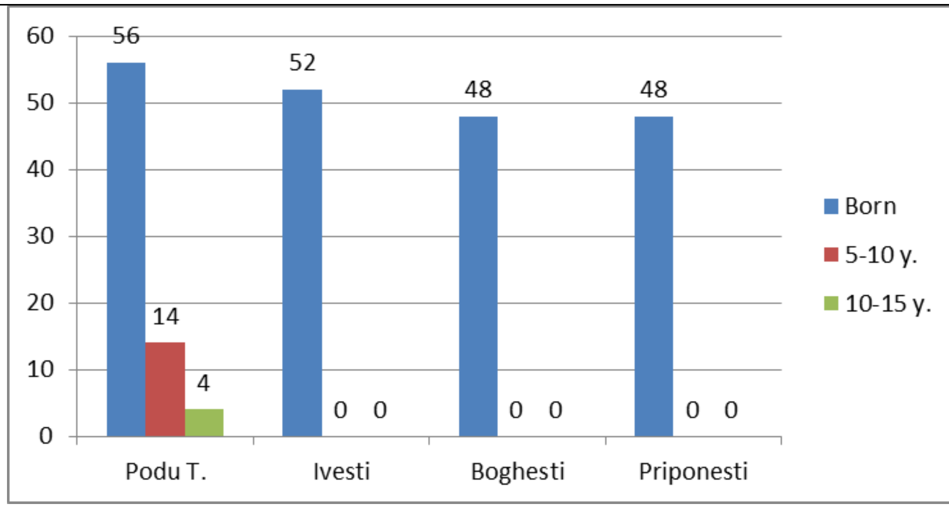
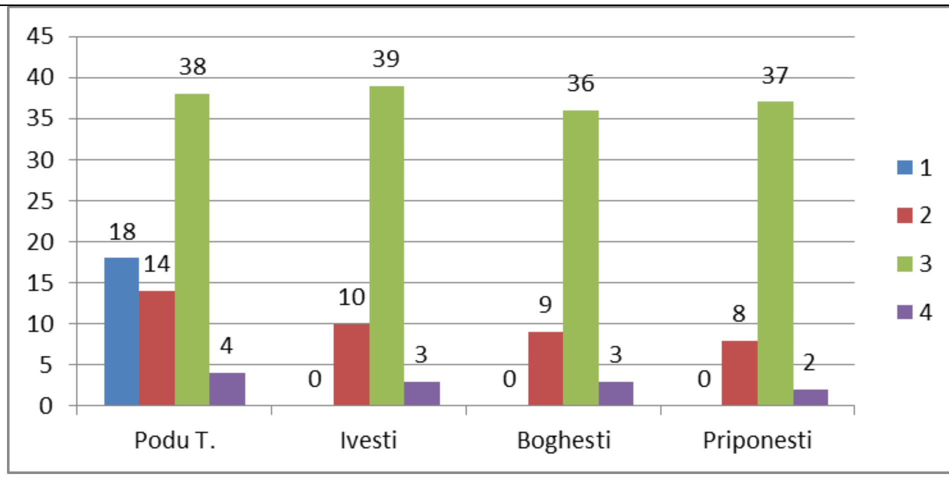
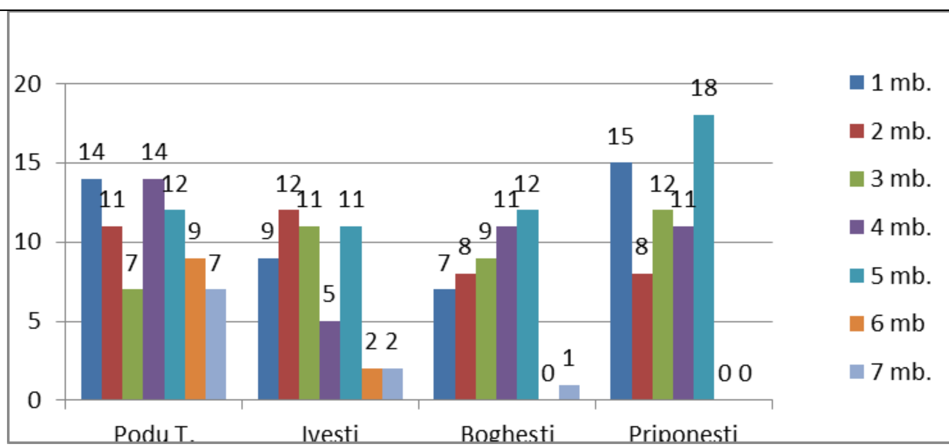
Table. 24. The comparison between 2002 and 2011 censuses

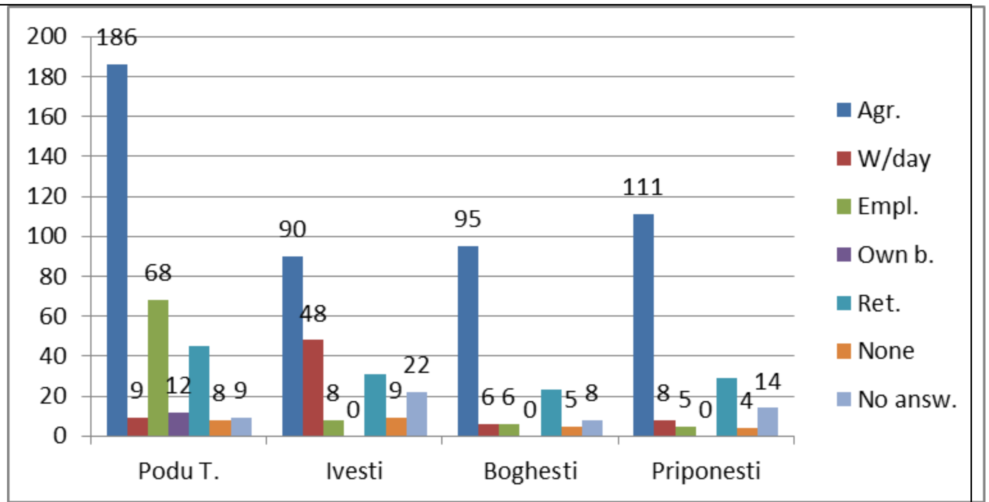
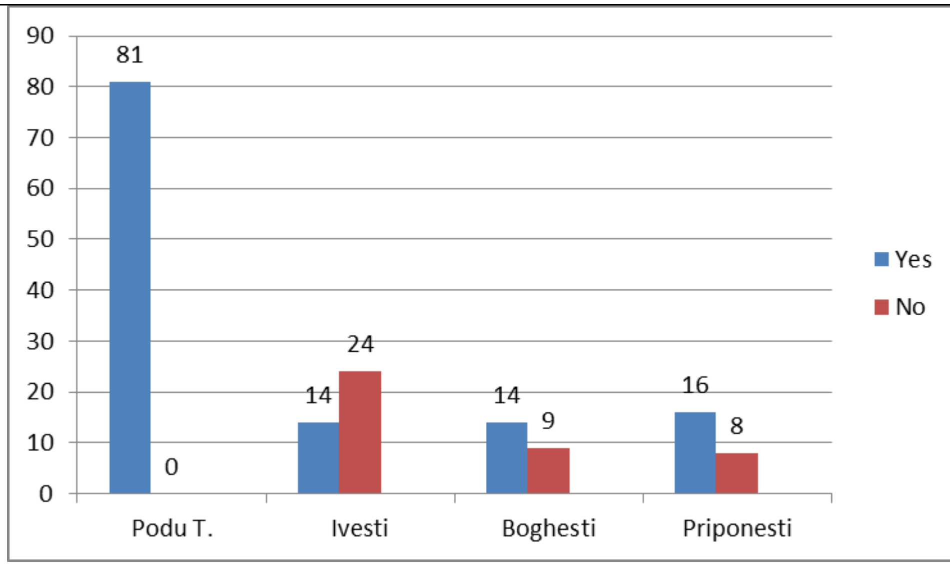
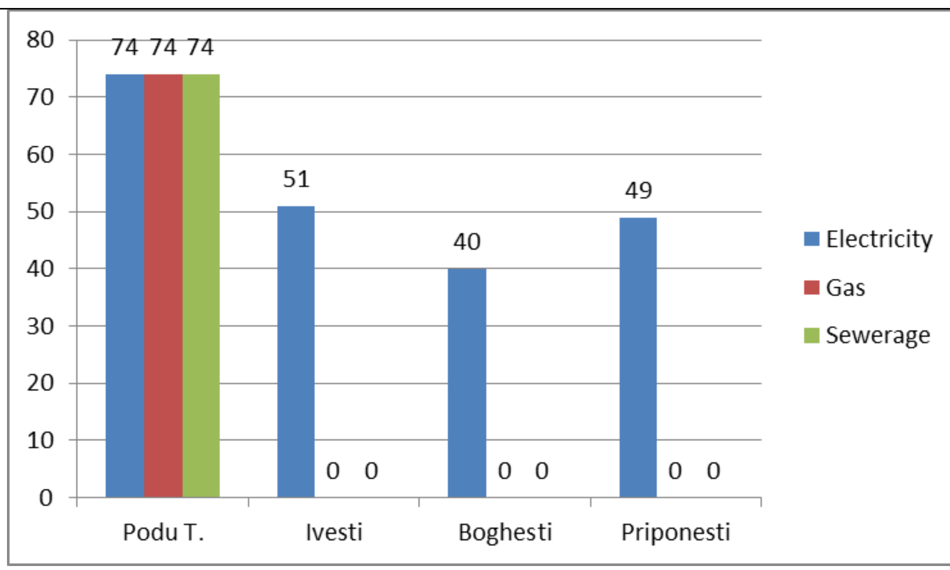
Commune	**Nr. inhabitants** (2011 Census)	**Nr. inhabitants** (2002 Census)	**Nr. inhabitants decreasing**	**% decreasing**
Podu Turcului	4617	5140	523	10,18
Bogheşti	1680	1835	155	8,45
Iveşti	2409	2874	465	16,18
Priponeşti	2223	2598	375	14,43
Total	**10929**	**12447**	**1518**	**12,20**

Regarding the sociological aspects, I developed a questionnaire in order to find data about the life standard in the investigated area and their opinion about this (Annex 1).

Table 25 is a synthesis of these questionnaires, showing very clear the comparison and the real situation between the studied human communities.

Table 25. Sociological investigation in the studied area

Nr. crt.	Question	Answer
1.	Since when do you live in this village?	
2.	How many generation of your family lives here?	
3.	How many members are in your family?	

4.	Which is the main occupation of the adults in your family?	
5.	Does the minors in your family goes school?	
6.	Do you have access to electricity, gas, sewerage?	

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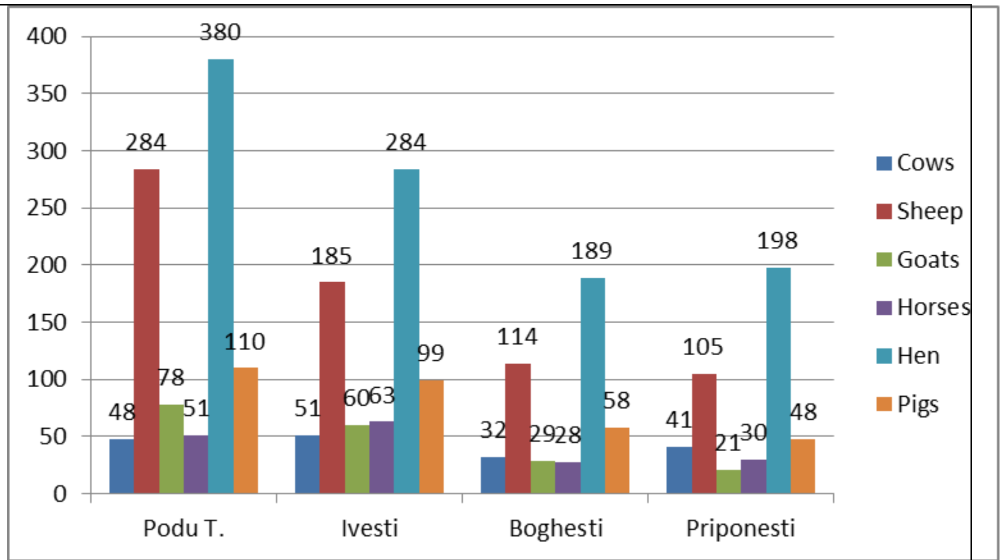
<td>7.</td>
<td>Do you grow animals in your household?</td>
<td>
</td>
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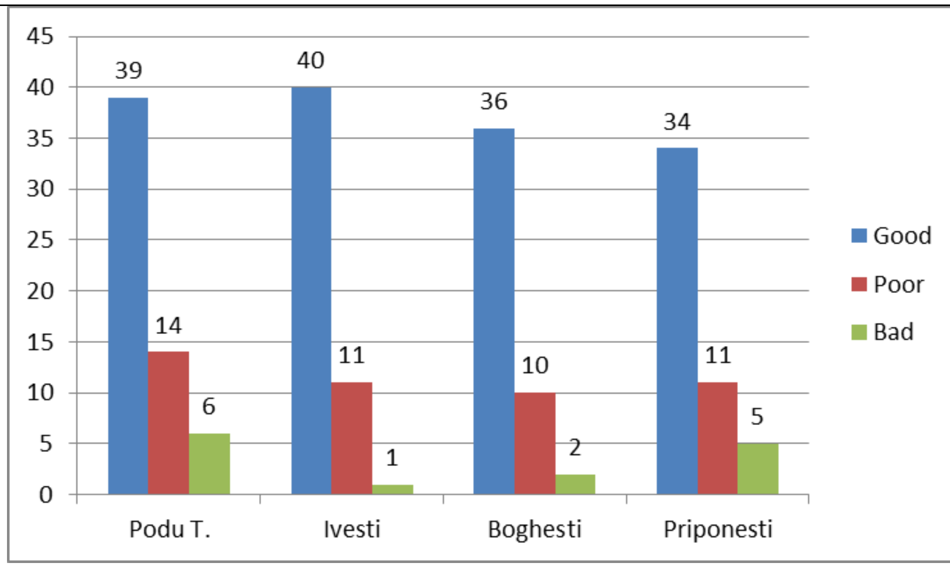
<tr>
<td>8.</td>
<td>Which is the health status in your family?</td>
<td>
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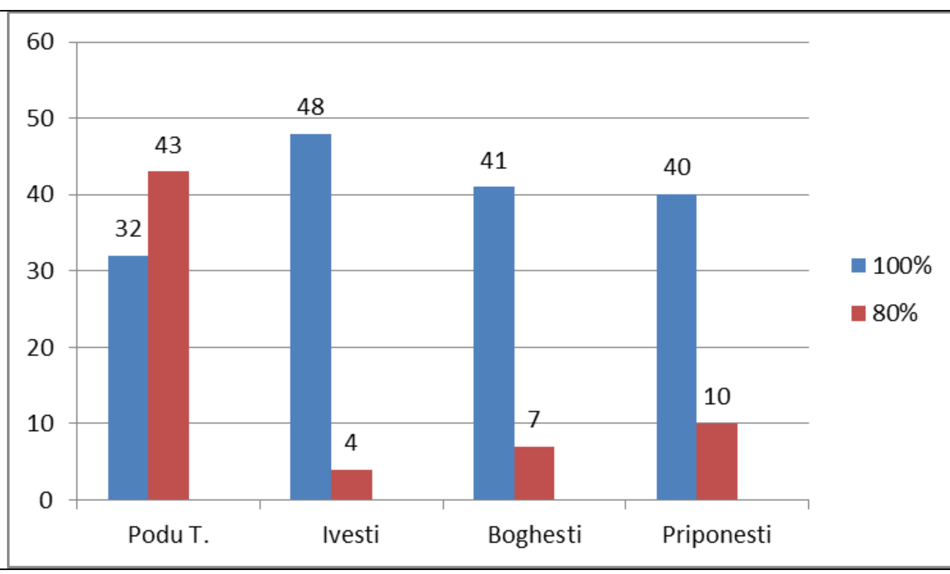
<tr>
<td>9.</td>
<td>In what proportion, the food consumed in your family is produced in your own household?</td>
<td>
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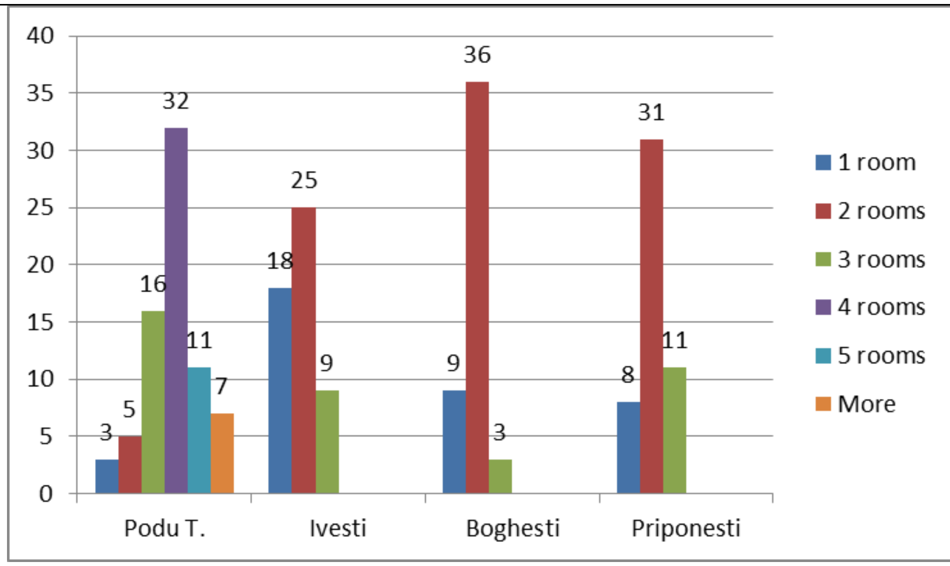
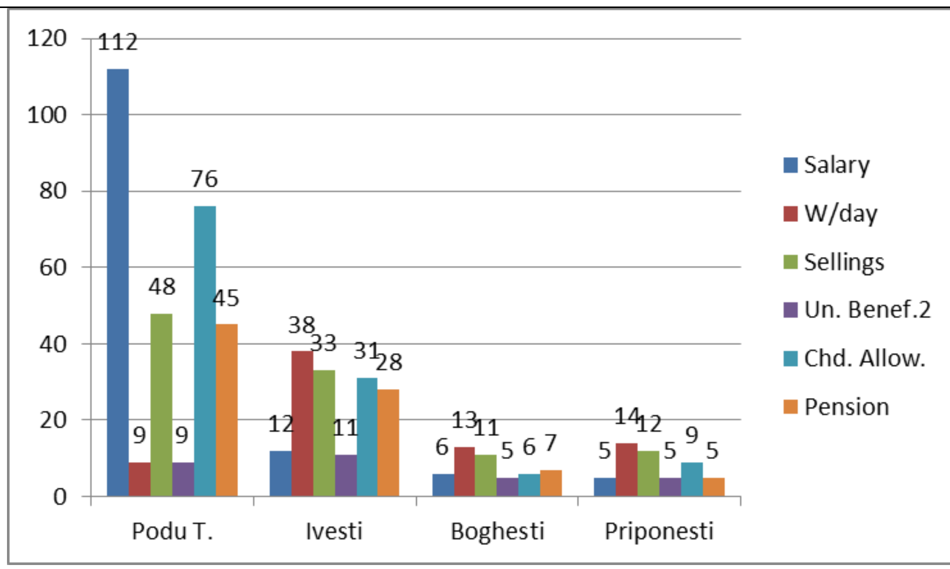
10.	How many members of your family consume alcohol and how often?	No answer
11.	How many rooms do you have in your home?	
12.	The money income in your family	

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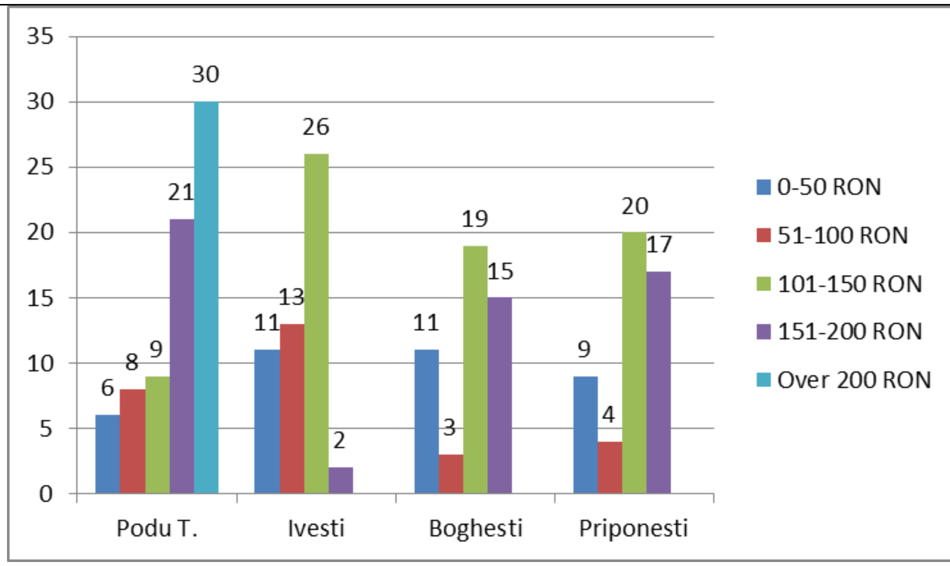
<tr><td>13.</td><td>Money spent last month in your family</td><td>
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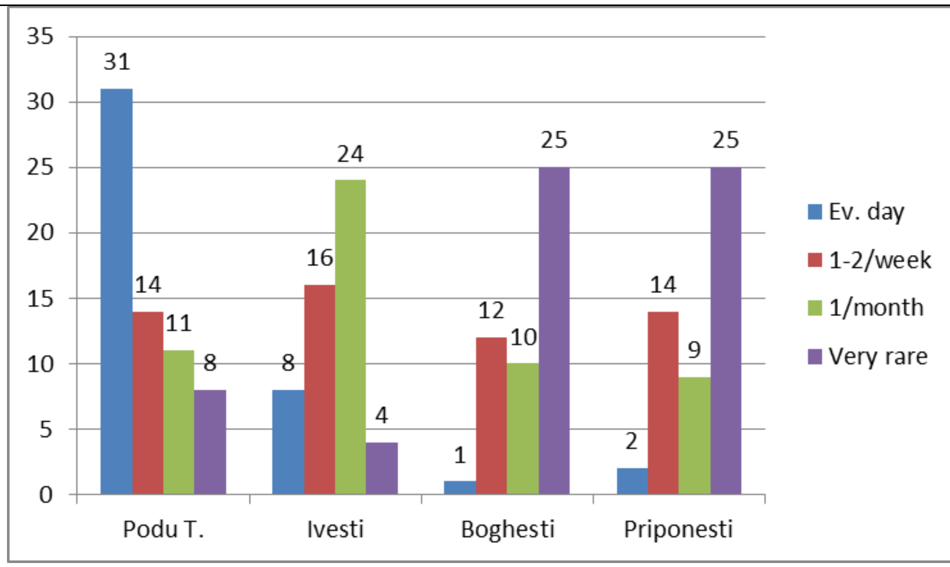
<tr><td>14.</td><td>How often do you travel outside your village?</td><td>
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From a total of 5321 conventional homes located in the studied area, 99,36% are private property, only 0,67% being owned by the state (Table 26).

Table 26. The dwelling property type in the studied area
(after National Population Census, 2011)

Conventional dwellings (homes)					
Commune	**Nr. of homes**	**Private property**	**Percentage**	**State property**	**Percentage**
Podu Turcului (Bacău)	2199	2191	99,6	8	0,4
Iveşti (Vaslui)	1059	1056	99,7	3	0,3
Bogheşti (Vrancea)	869	862	99,2	7	0,8
Priponeşti (Galaţi)	1194	1178	98,7	16	1,3
Total dwellings	**5321**	**5287**	**99,36**	**34**	**0,67**

Analyzing table 25 and 26 from above, we can find the following social aspects, to conclude:

(1) There are not many people working in the other location than their village, many of them living together with their parents or with grandparents.

(2) There are children who goes to school. In my opinion, this is due the allowance they get from the authorities. I think they are not very interested in the acquisition of knowledge by education. On the other way, I consider the lack of education in the family, manifested by the lack of communication between parents and children in general and in particular by the lack of motivation of excellent benefits of the acquisition of knowledge obtained at school and the final result of this, a good job that could change their life standard.

(3) Many members of their families moved in the nearest towns (Bârlad, Vaslui, Negreşti) because they found a job and a better life there. They come time to time to visit their parents or grandparents and to bring them some goods or products from town. Talking to them, some people affirmed they are pleased of the choice because they use the products from their household. They work the land, money being only to buy a few products. Also, they can change products to each-other. Unfortunately, some people affirmed they are not pleased of the choice, but they don't have where to move.

(4) I estimate that in the future, this area shall suffer a severe decrease of population. Thus, we estimate that in about 30-50 years, the hamlets Căbeşti, Bogheşti will remain unpopulated because are poor and do not possess any of the actual civilized status in terms of infrastructure, gas, sewerage, electricity, running water. Another reason is the population of this area is much aging,

(5) The active population is around 49% of total, over 90% (Census 2011, Annex 1) working in primary sector, especially agriculture, but we are speaking of subsistence agriculture, with a very low yield, based on plant crops and less on animal growing (Table 27). The lack of sustainable agriculture based on scientific knowledge that to have like the main objective, the protection of environment and natural vegetal and soil resources has caused the strong degradation with negative effects in the investigated area that requires, at the moment, ecological reconstruction.

Table 27. The livestock monitoring in the studied area (modified after Niacşu, 2012)

Livestock	Number of heads	Number of heads/100 hectars	Number of heads/inhabitant
Bovines	6 714	67,67	0,61
Swine	6 857	69,10	0,63
Ovine	17 011	171,44	1,55
Poultry	101 325	1021,21	9,27

Another issue which I want to expose in my present work, is the ***alcohol consumption***. In the Romanian rural areas, alcohol acts as a kind of curse.

The factors promoting alcohol abuse among the rural population is poverty and unemployment, that leads to an increased number of drinkers and those addicted to this vice, and finally we find that dozens of children remain orphans, hundreds of broken families, women and children physically and mentally abused, and most tragic is the loss of life.

Analyzing the sociological study I have performed, I found that there are two categories of alcohol consumers: those who drink just to be in tone with others and which I wouldn't say they are addicted to alcohol, I prefer to say "alcohol attraction". They are attracted to alcohol as a tradition, to be like other people, because their parents and grandparents used to work with a bottle of alcohol in the bag.

The second category is the heavy drinkers, or the alcohol addicted. People in this category are not interested in any job, any work, family and children. They walk around looking for alcohol. Sometimes they make temporary easy works to earn money for alcohol or they are paid directly in alcohol. When they are drunk, they have no self control and they act like criminals against their family or other members of the community. I think this category is very large and it is one of the most important reason why people living in poor or disadvantaged areas, has a very hard life, at very low level. In Romania, we have a saying: *man sanctifies the place*. I think that it is in their power to have a better life. Unfortunately, poor people are waiting for help from the authorities, from other people, from the church or from the E.U. They are not interested in social programmes like professional instruction or reconversion.

In a sociological way, poverty combined with alcohol leads to a higher criminality. Excessive drinking leads to criminal behavior.

If we forget for a while politics and we take care of clearing this vice that reaches mass level, which causes damages to the whole society, the progressive effects will be felt. So, today we shall save a family, tomorrow a child that it is in danger remain an orphan, and finally, a man or woman will be a value to society if they will stop drinking. Alcohol (spirits, beer, wine) leads to domestic violence and ~~to~~ for other members of the community, to tragedies and an increased criminality.

Very worrying is also the fact that many times women consume alcohol for the same reasons as men.

The main causes of domestic violence are**:** alcohol (85%), poverty (64%), low level of education (45%) and unemployment (21%). Other causes could be that the man must be authoritarian in the family, or women emancipation (Figure 46).

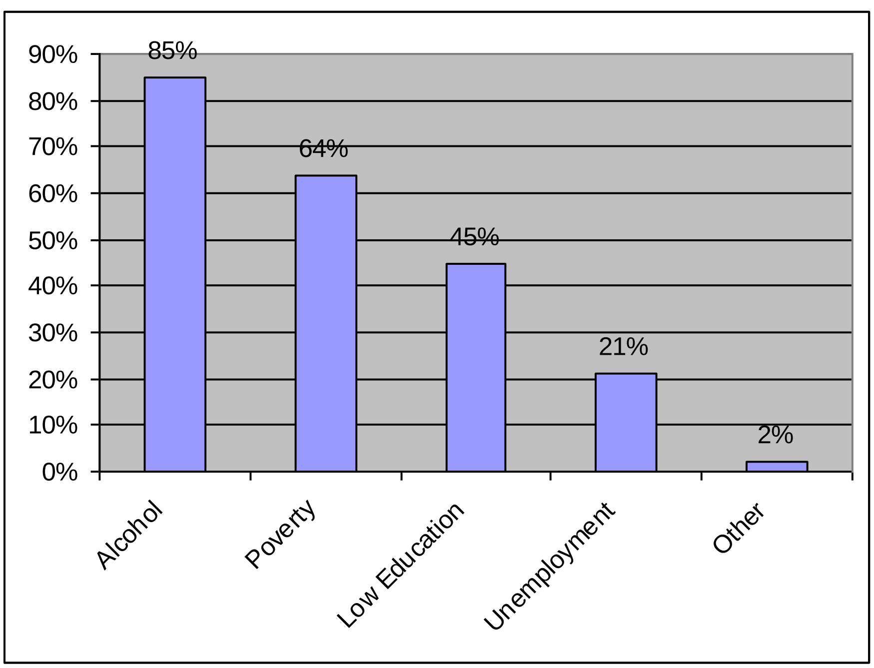

Figure 46. The main causes of domestic violence

The industrial development of the area was based on natural, politico-economical, technical and social premises. Compared to other geographical areas, natural resources are less quantitative and qualitative representative.

Small area of the forest and its irregular distribution in the territory reveals the lack of wood in the Tutova Hills. Population and economic agents are supplied from Bacău, Neamţ and Suceava counties. Water resources are reduced in the investigated area due to climatic and geological conditions. For this reason have been built accumulations, including Fichiteşti. In the dry period, the water level falls much closer to depletion.

Due to the hilly relief, relatively high and unstable, due to frequent landslides and gullying, roads and railways are mostly oriented NW-SE, following the river valley. Density of railways in the Tutova Hills is 3,7 km/100 km^2, and peripheral position of the railways makes the percentage of localities served directly by rail to only 3%. Roads have a density of 56 km/100 km^2, partially satisfying the needs of the residents, but the main roads have an orientation similar to railways along the river valley. About 90% of the roads are in rural areas, being quite difficult accessible. Furthermore, we note the lack of modernized roads with E-W orientation. For these reasons, the index of isolation of some areas is quite high. Average distances from the villages to residence commune varies between 5,5 and 24,2 km.

Land restitution is another important issue and influenced on a high level the life standard in the studied area, but all over Romania. In general, in post-communist countries, and especially in Romania, the deterioration of the relation between communities and the land is due to the change in property relations. The loss of land private property altered deeply individuals perception on the afforested land, especially because the period of time that is characterized by such an abnormality was prolonged. The forty-five years of communism, and the lack of private property, led to an alienation of rural people from the land, which was once so vital for survival. That period altered deeply the life style of the rural population. The old economic and social organization specific to the rural space were slowly replaced with the urban ones. A great number of countrymen, losing their land as a workplace (forest and agricultural land) have reoriented towards industrial activities found only in towns, leading to an intense migration from villages to towns.

This complex socio-economic process had a great impact on the Romanian countrymen's behavior, on the owner of agricultural and forest land. Especially in the second case, where for many years all property belonged to the state, the effect was dramatic on perceptions of both the inhabited place and of the place formerly owned. This is why we have to understand the difficulties of the restitution process confronting Romanian agriculture and forestry (Guran-Nica and Lawrence, 2008).

It is felt the lack of a town capable to polarize the whole development of the area and to correspond to regional centers like Iaşi and Bacău. The main towns of the district – Vaslui and Bârlad – feel the industrial restructuring (practically, almost its dissolution) and inevitable migration of young specialists. Out of these two, here configures an administrative pole, Vaslui, which is a county seat, where the county institutions function, it is also an economic pole. In Bârlad there still function a few industrial units which sustain the local economy. The development of these two towns will have to take into account, both, their own development needs, but also the relationships with rural county, for which towns have to be markets and generate jobs.

The problems of the rural areas are old and they are generalized and seem constantly to be caused by two great deficiencies: jobs and infrastructure. A part of the population generally survive due to the funds they receive from the national government.

Different forms of social support are added to those above, on which, dwellers of rural county largely depend for many years. Negative social phenomena, like alcohol consumption, domestic violence and lamentation in poor situations are inevitable, being quite often noticed in rural communities. The living conditions in the rural county are not attractive at all for the young ones, especially due to the fact that they have access to information and they inevitably are attracted by communities which are able to offer them a better life. In this way, the villages grow older gradually, they are permanently depopulated of elite, leaving rural communities without any future.

The only salvation for these villages seems to be the agriculture. But we do not refer to a rudimentary agriculture and chemical fertilizers, neither understanding selling grain as being the purpose of agricultural activities. Modern and clean technologies and techniques, the local association of producers and owners of agricultural lands and the development of manufacturing industries, can provide a local economic and sustainable development.

In the perspective of the sustainable agricultural development and even for the subsistence agriculture, there is the problem linked to infrastructure access roads to the agricultural holdings. We also refer to side roads, parallel to the ways of national and county interest, which should be for the circulation of agricultural vehicles.

At the moment, the absence of such roads starts to become a more and more difficult problem, both, for farmers and for traffic participants.

One of the few solutions is attracting grant funds from national and European sources. In this respect, there should be continued the actual adopted direction: the implementation of European projects of infrastructure and political lobby for supporting the projects for rural areas infrastructure.

The salary income of Vaslui, Vrancea, Galaţi and Bacău districts are quite low and together with high unemployment and a large number of socially assisted, contribute to maintain the buying power at a very low level. In this way, a vicious circle is formed, as companies offer low salaries, and as a consequence, they suffer from reduced local demand. More than that, the unmotivating salary level creates a deficit of specialized workforce. For instance, most young people who graduate, exclude option of coming back to their district in order to start a career. The perspective is equally dark as most of the high school students do not want to come back to their district after graduating, because of the lack of jobs and salary level.

Services are not credited with high chances of success in these rural areas. A possible explanation derives from low buying power of the population. In this context, the main priority for the economic development is agriculture, in the opinion of the local communities. Although with a significant gap, food industry works, processing local agricultural products.

Poverty is the term generally associated to the rural county of Vaslui. The difference between villages and towns of Vaslui district is great even if the urban centers are not very much developed. The existing situation in rural Vaslui county has determined the characterizations such as: „the poorest in the country", „*the poverty pole* of the European Union", which worsens the situation.

Rural settlements in Tutova Hills are not served by polarizing labor centers in the area. Between Siret Valley and Bârlad Valley are lined up entire communities with high poverty indices, explained not only by the scarcity of reliable contractors (entrepreneurs) to raise the number of employees, but also the complete absence of local polarization links (local contractors) is the most conclusive to explain the very high incidence of villages that do not have even a single employee.

The reasons underlying the underdevelopment of this vast and relatively well populated area, consist of multiple explanations, starting with the hostility of the geographical environment: consistent valleys enclosed narrowly enclosed, high energy relief, lithology predisposed to slope processes, scarcity of water resources, high sloping processes that creates difficulties for agricultural purposes, especially mechanized agriculture. The mentioned aspects are complemented by poor organization of socio-economic system: domination of longitudinal direction of the communication ways, requiring drainage of social systems consistent with the natural tendencies of concentration, always located peripheral to the area in question. More, we can mention the historical instability of these discontinuous and preferential settlements, from lower valleys to the upper hillslopes (Poghirc, 1972), which complicated the settlement system, increasing the number of network elements, but diminishing their human resources of each one settlement. It has revealed a positive correlation between the size of settlements and accessibility to peripheral axes formed by the rivers Siret and Barlad, gradually reducing the availability to upstream valleys and increasing the social risks of these isolated communities.

The rural population density is of 53,5 inhabitants/km^2. If we make a comparison, the rural density of the North Eastern region is of 63,4 inhabitants/km^2, and of Iaşi district is of 83,4 inhabitants/km^2. The population is affected by a pronounced aging process which is actually more stressed than the official data shows (1114,5 ‰), because an important part of the young population is gone to work abroad or in other cities of the country. The aging phenomena have all the premises of extending in the near future, taking into consideration that the rural natural increase is negative.

The average age of the population of the rural county is of 55,1 years for men and 54 for women. In urban, the corresponding values are of 35,3 for men and 37,4 for women.

The living area in a rural home is of 13,1 m^2/inhabitant, with 0,4 m^2 larger than in urban areas, although the average surface of a rural home is of 33,3 m^2/home, with 3,5 m^2 smaller than an urban home.

The economic activity of the studied area is weak. Only about 10% of the economy of the district is reported in rural (Local Development Plan, GAL Colinele Tutovei, 2012).

The percentage of people without a job is very large, a great part of the population becoming dependent on different social benefits. Animal agricultural production was followed by a period of general involution. The only activities which developed along the last 5 years were poultry and apiculture. Vaslui district has some important vineyard areas, some of which being famous among the Romanian vineyards. Thus we can enumerate the vineyards of Huşi, Bohotin and Colinele Tutovei (with Iana and Tutova centers).

The wine and grapes production has registered a decreasing trend along the last 5 years, as a consequence of reducing the areas occupied by vineyards.

According to the Directorate for Agriculture and Rural Development Vaslui, in 2008, only 0,16% (650,2 ha) of the agricultural area of the district was certified to practice ecological agriculture and only 11 producers were certified (out of whom 8 were apicultors), although the potential in this way is much greater.

The number of the agricultural machines available in rural areas, reported to the arable area, is quite low. So, about 90 ha of arable area are assigned of a tractor, while the national average is 61, 7 ha/tractor. The main problems of the rural county of Vaslui district are mostly generated by the very low level of the economic development, which chronically affect the local communities for decades. The poverty rate reaches the highest standards in the country, and if we compare this situation to the developed countries of the European Union, the reality is even disastrous. It is very clear, the situation of the village of Vaslui is impressive.

During the communist period, the agricultural activities were collectivized, the workforce of the rural county being concentrated especially towards these. After the restitution of agricultural lands, every land owner was free to cultivate his own land using the technique he had. The „communist" agricultural infrastructure was largely destroyed. The result was disastrous – the elderly with miserable pensions, young people without local perspectives, fragmented agricultural areas being worked with technologies of the XIX-th century. Agriculture, evidently subsistence agriculture – is still the main living source for many inhabitants of the rural county of Vaslui. The young ones left for jobs generally abroad, the elderly cannot cultivate the few lands they have, so, large areas remain uncultivated. Investors have lately appeared who practice agriculture on large areas, using modern technologies and offering summer jobs. Small farmers are added to these who try to exploit as much as they can the potential of the land they work. The main problem is the low level of subventions needed for agriculture (comparing with other EU countries) which determines the prices of the agricultural products being uncompetitive. As a result, agricultural activities have become economically disadvantageous.

In such conditions – the lack of investments in technology and for improving the soil quality, black illegal work is maintained in agriculture, because of low financial resources. Besides all these, there are also problems with the marketing of farm products: the prices are neither standardized nor stabilized, the manufacturing industry cannot absorb the entire production or it prefers imported raw materials, which are cheaper. As a negative consequence, the small producers should store the production ~~in~~ under improper conditions that affect the quality of products and the human health. Irrigation facilities are missing, so, in a droughty year, there are high risks to obtain very low yields. Specific infrastructure is very costly and the project proposals of the small producers association are not agreed locally, due to the lack of “open minds” or recent past collectivized agriculture.

The fact that there are few producers of certified organic farming lies, especially in the lack of information about the opportunities and benefits of this certification. All techniques of the organic farming respect and protect the environment, all developed investments being favorable for maintainance of the equilibrium of ecosystems. In this respect, organic farming is different, confronted by conventional agriculture, in two crucial directions, like: fertilization and plant nutrition and technologies used for pests and diseases control in the plant protection. Thus, the fertilization and plant nutrition are provided from organic sources to stimulate also the activity of soil microorganisms with role to mobilize the nutrients from soil resources. Referring to the plant protection against pests and diseases, under organic farming, the amount of pesticides is significantly reduced, using low doses that do not pollute. In this respect, foliar fertilization as unpolutant and unconventional method, as well biological control represent efficient strategies for sustainable agricultural management and soil environmental health.

The degree of coverage network utility is very low, roads raise high problems of accessibility, public services are few and of a poor quality, the information is also low. A huge percentage of the population is receiving some form of social benefits. There are families where the only source of income is represented of the social and child allowances, and this situation has become normal, even satisfactory for many people and local authorities.

Many social problems arise, including alcoholism and domestic violence, being well represented. Many children are left without parental supervision for various reasons. Thus, the education system fails to fill the gaps of their education. In short, the attractiveness for living in Vaslui villages is very low. The only "new" inhabitants are people born in these villages who have returned from the city after they have retired, hoping that they will supplement their income consuming their own agricultural products. There are also very rare cases of people moving in these villages, by marriage.

Business units in the villages of Vaslui are mostly stores supplying people with all products they need, from food to school supplies and, of course, alcoholic drinks often "subsidized" of social benefits. The only way to solve, at least partially, the main social-economical issues of population from here is the association between local government and the partnerships between local government and private investors, where is possible. From a demographic perspective there is a risk of a long term depopulation of villages meaning the disappearance of rural communities in the county. Young people leave in villages because of shortcomings and poverty, the rural population ageing increasingly more and more. Thus, the young people represent only a limitative support for the old people and not a real support for the future. In present, average age of the population is 55 years and natural increase recorded negative annually. Thus, even if the effort could cause local workforce, meaning that would solve a big problem today, it could not represent a real offer.

For the small farmers, one of the problems is the lack of the market to sell their products. Next, in order of importance, is: aging population, lack of funds to finance of the projects of local sustainable development, land fragmentation and the lack of irrigation.

Another social-economical issue that is actually a result of other problems that occur in the investigated area is dropping out of school The explanation for the children drop out of school is the extremely low life standard of their families, from many reasons, and, of course, the lack of motivation for the education of their parents (Table 28).

Table 28. The education level of population living in the Southern part of Pereschiv basin (original, data from National Population Census, 2011)

COMMUNE	RESIDENT POPULATION OF 10 YEARS OLD AND OVER TOTAL	LEVEL OF EDUCATION GRADUATED									
		Superior		Post-secondary and foremen	Secondary				Primary (4 classes)	No education	
						Superior		Inferior (gymnasium-8 classes)			Out of:
		Total	University degree		Total	Highschool	Professional and apprentices			Total	Illiterate persons
PODU TURCULUI	**4041**	**289**	**265**	**122**	**2584**	**778**	**436**	**1370**	**901**	**145**	**47**
Males	1964	144	130	53	1344	377	322	645	371	52	14
Females	2077	145	135	69	1240	401	114	725	530	93	33
PRIPONESTI	**1967**	**38**	**37**	**21**	**1340**	**182**	**270**	**888**	**504**	**64**	**17**
Males	961	21	21	10	703	96	206	401	202	25	8
Females	1006	17	16	11	637	86	64	487	302	39	9
IVESTI	**2144**	**41**	**41**	**3**	**1351**	**158**	**292**	**901**	**660**	**89**	**59**
Males	1055	23	23	3	710	72	206	432	302	19	10
Females	1089	18	18	-	641	86	86	469	358	70	49
BOGHESTI	**1496**	**49**	**49**	**11**	**974**	**188**	**180**	**606**	**417**	**45**	**20**
Males	748	24	24	4	536	100	141	295	163	21	5
Females	748	25	25	7	438	88	39	311	254	24	15

The total population living in the Southern part of Pereschiv basin is 10929 inhabitants. According to table nr. 24 there are 9648 persons of 10 years old and over this age**.** The rest of 1281 persons are children less than 10 years old (figure 47).

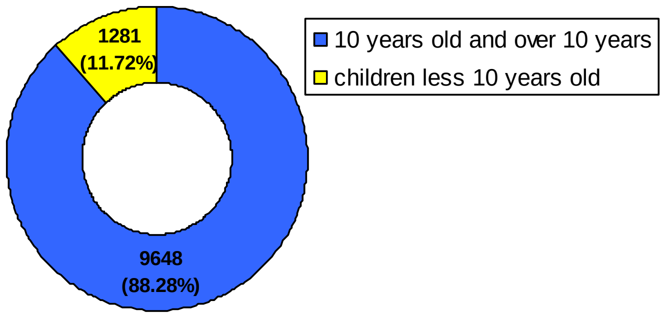

Figure 47. The age structure of population in Southern Pereschiv basin

Taking into consideration the level of education of 9648 persons of 10 years old and over this age, figures 48 and 49 highlights that 417 persons have **superior** education (4,32%), 157 persons have **posthighschool** or foremen qualification (1,63%), 6249 persons have **secondary** education (64,76%), 2482 persons have **primary** education (25,73%) and 343 persons (3,56%) have **no education.**

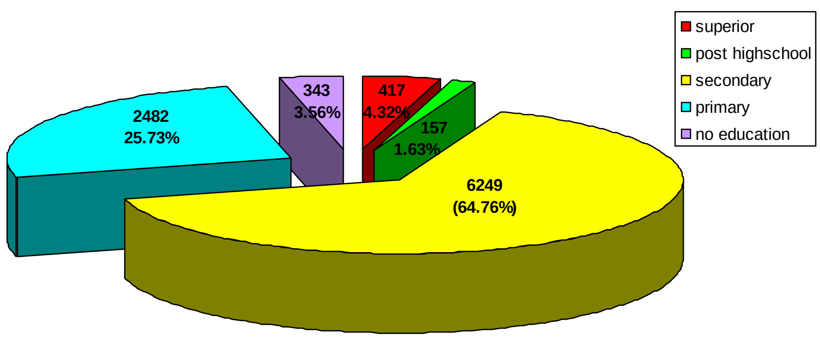

Figure 48. Level of education of population in Southern Pereschiv basin

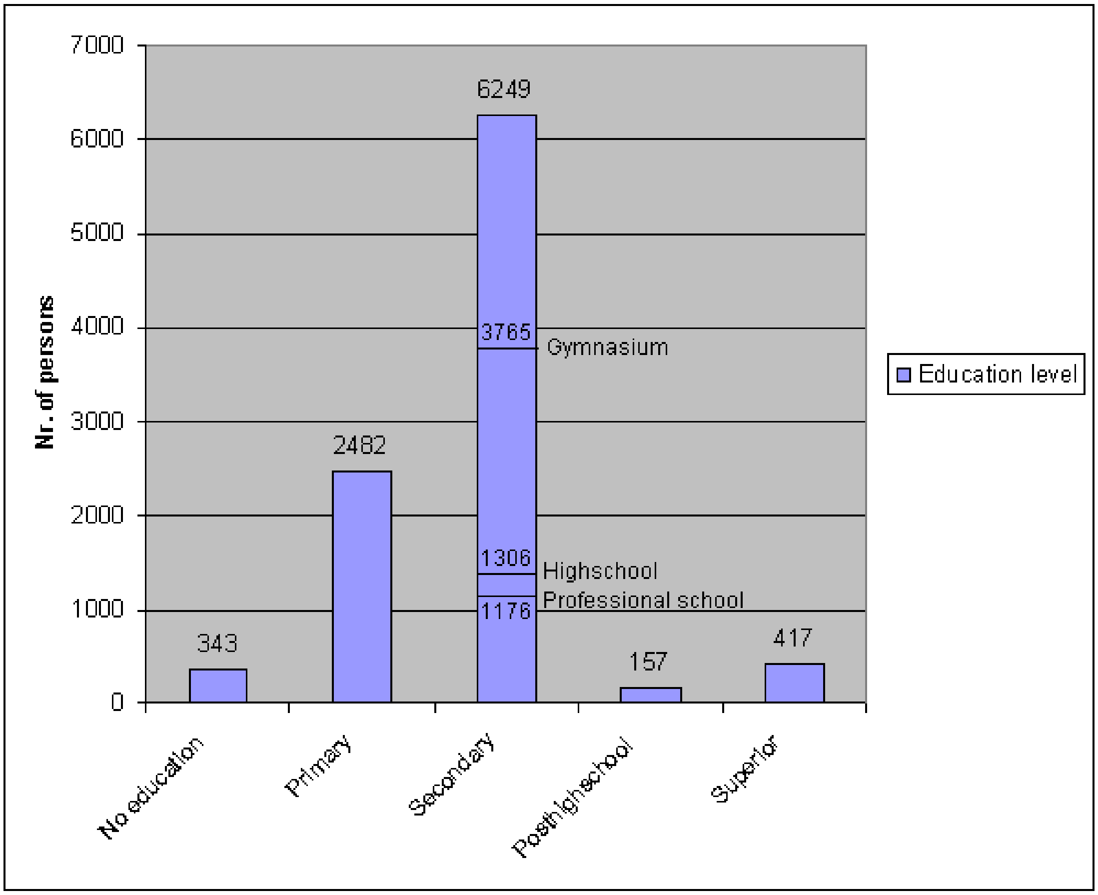

Figure 49. The level of education of population living in the studied area

8
Drinking water quality in the studied area

Laboratory of the Management System for Water from Vaslui, Romania, oversaw groundwater quality in 27 wells belonging to 18 localities. They reported concentrations exceeding the maximum permitted ammonia (53,8%), nitrogen (17,9%) and total iron (97,4%).

Regarding the water quality in Tutova Hills, I was focused especially on water from wells, because this is the only water supply for the households in this area. Tutova Hills are grafted onto Kersonian, Maeotian and Pontian deposits, represented by sands, clayey sands and clays, in various alternate. In the Southern part of Pereschiv basin, the aquiferous complex has the origin in superior Pliocene deposits. Being an exclusively rural area, the anthropic accidental water pollution is rare and especially by agricultural diffuse sources like nitrogenous fertilizers. The accidental water pollution is a little higher in the neighborhood of urban areas. We collected 4 water samples from wells in Pereschiv basin These samples were analyzed in the Laboratories of Water Administration Prut, in order to find the quantity of nitrogen, heavy metals and pesticides. The results shown that never found heavy metals and pesticides. This could be explained by the fact that in this area agriculture is made mostly by ancient methods and the population does not use chemical substances, only in the spots where it is practiced agriculture, they use small quantities of fertilizers based on nitrogen. In Podu Turcului was registered 1,5 times more concentrations of nitrates (64,05 mg/l) than maximum accepted (45 mg/l), due to the pollution from diffuse agricultural sources (nitrogenous fertilizers). The maximum concentration of amonium allowable in drinking water is 5 mg/l. In Tutova Hills was found a five times lower concentration (Table 29).

Table 29. Nitrogen compounds content in Southern Tutova Hills (mg/l)

Drilling	NO_3	NO_2	NH_4	pH
Podu Turcului 1	64,05	0,20	1,23	7,08
Podu Turcului 2	15,37	0,19	0,84	7,24
Ciorăşti 1	6,43	0,05	0,35	7,64
Ciorăşti 2	2,49	0,13	2,50	7,49

In May 2001 was registered an extreme value of 1089 mg/l, the maximum accepted limit was over by 24,2 times. The content of nitrites were lower, 0,2 mg/l while the maximum accepted limit is 0,5 mg/l. Taking into consideration the variation in time of nitrogenous compounds, the groundwater has inferior quality, being considered undrinkable. This situation is not generalized in all Tutova Hills, but only in some points. There were not registered fatal human cases caused by intoxication with nitrites or nitrates. Generally, Tutova Hills is not considered a nitrate polluting risk zone (Figure 50) but could be in the next period, without a sustainable development.

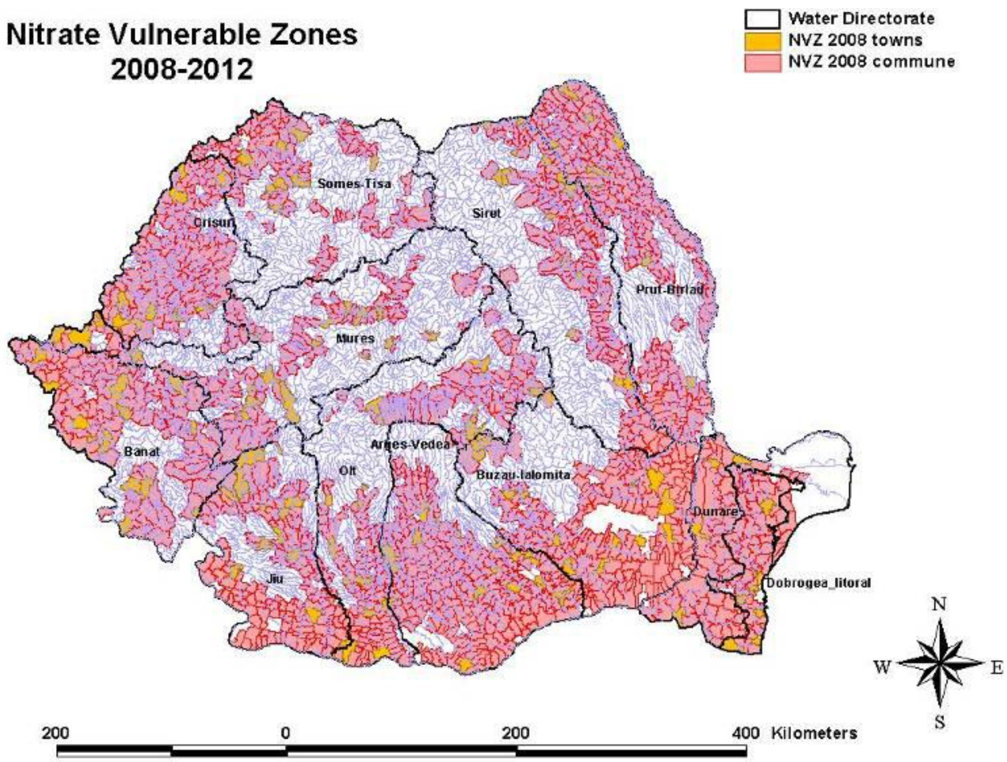

Figure 50. Vulnerable zones of nitrate pollution in Romania
(www.inpcp.ro; www.inpcp-campanie.ro)

Using large amounts of nitrogen fertilizers, by the negative practices of intensive (conventional) agriculture, the excess of nitrates get into the groundwater and surface water representing a real threat for the animal and human health.

Human or animal waste can contribute to nitrate contamination of groundwater. Nitrate levels in drinking water can be indicators of water quality in a region. High levels of nitrates can indicate the presence of other types of contaminants such as: organisms which can cause diseases, pesticides or other organic or inorganic components which may cause various health problems.

Nitrogen fertilizers are the number one source of nitrates in drinking water, while the second source is human waste and animal manure. These may contaminate the drinking water including bottled water.

Ministry of Environment and Forests of Romania urges farmers to apply a maximum amount of 170 kg of nitrogen per hectare, achieving agricultural works so as to avoid leakage of nutrients into water courses, crop rotation and respecting periods of prohibition of manure application on soil. Limit concentration of nitrates in water is 50 mg/l, according to official standards (the law regarding drinkable water quality 458/2002 and STAS 1342/1991). But many doctors consider this value too high, especially for infants and young child and recommend a maximum of 25 mg nitrate per 1 liter of water. Nitrate pollution in Tutova Hills is one the lowest (0-25 mg/l) in the country.

The Environmental Protection Agency from USA has established a maximum level of contamination with nitrates of 10 mg/l for drinking water safety. Nitrates at this level or a higher level can cause a potentially fatal blood abnormality at children less than 6 months of age, called “methemoglobinemia” or “baby blue” syndrome, which consists in reducing the capacity of cells to transport oxygen through blood. The amount of nitrate in water is influenced by natural processes and anthropogenic impact by irrational and unscientific use of fertilizers and pesticides (Figure 51).

Usually, we expose ourselves to the danger of nitrates, by what we eat. Traceability of the nitrates in the food chain highlighted variable residual amounts in various vegetable and meat products.

Study of the traceability of nitrates and nitrits from the soil- plant- environment- groundwater- surface water- animal- human must be continuously monitored to avoid illness.

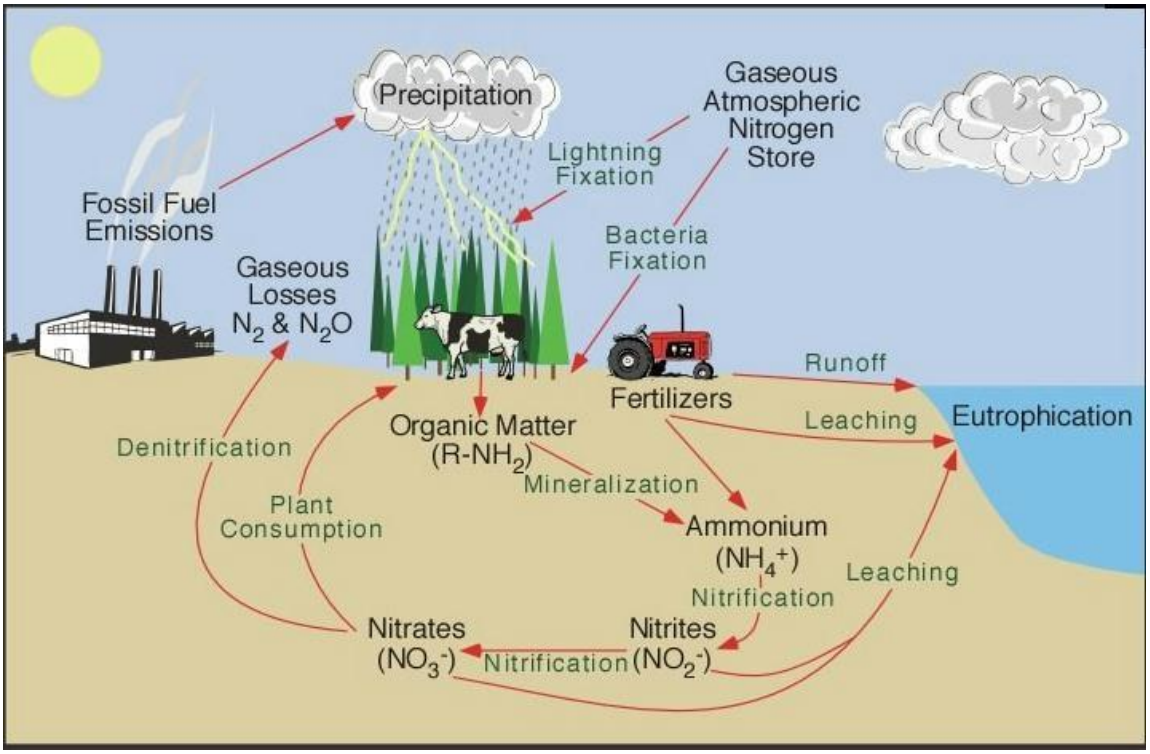

Figure 51. Nitrogen cycle in nature
(http://greenly.ro/apa/poluarea-apei-cu-nitrati)

Children, who consume large quantities of nitrogen in water, are predisposed to "baby blue", to respiratory problems due to improper circulation of oxygen in the blood. In the human body, nitrate (NO_3^+) is transformed into nitrite (NO_2^+). Combining with *hemoglobin*, they form *methemoglobin*, which is unable to establish and to carry oxygen from the lungs to the tissues, leading to lack of oxygen, expressed by cyanosis, suffocation and death. The major problem is that methemoglobin in the body of a newborn child, can not transform into hemoglobin, as in adults body. The danger of nitrates to human organism consists also in their transformation in nitrosamines and nitrosamides which have carcinogenic properties. Pregnant women with low stomach acidity, and people with deficiencies of the enzymes which changes methemoglobin back to hemoglobin, are exposed to methemoglobinemia, induced by nitrates. The best known symptom of this disease is that it males the skin bluish, especially around the eyes and mouth. Other symptoms are headache, vomiting, weakness and heavy breathing. There are studies showing the link between births with problems and a high intake of nitrate at pregnant women (Aschengrau *et al*., 1993; Bruning-Fann, 1993). They must avoid water consumption of nitrate levels greater than 10 mg/l.

In case of monitoring of raw water for drinking water state there were identified exceed of suspension, Mn (manganese), Pb (lead), B (boron).

Conclusions

The principal aim of this thesis is to improve the total qualities of the Tutova Hills area. This is why this study involves a general objective, focused on holistic assessment in the study area, in the context of The Thematic Strategy for Soil Protection and the UN Commission on Sustainable Development (CSD). From the overall, emerges as a specific objective, to identify risk factors for sustainable development: the aging population, lack of infrastructure, soil quality, lack of attractiveness for tourists and investors, difficult access to health services, education, etc.

We have in our plan, to involve local administration, politicians and the possibility to atract people to invest money here, especially in organized agriculture or recreation, such fishing or hunting, the final aim being to increase the life quality of local people. To achieve the ecologically sustainable management of the area, we shall propose an action plan of technological, scientific, organizational and economic measures.

The whole Tutova Hills area is a typical rural area, poorly developed, where over 90% of the active population is working in the primary sector. Actually, this region deals with subsistence agriculture, described by very low yields. It is based on crop production resulting in a high pressure on the soil cover. In these conditions, the soil becomes the most important local resource. Thus, it appears the need to evaluate the capacity of soil to support basic human activities in the area.

About 50% out of Vaslui County budget for 2010 was allocated for security and social assistance. All these shortcomings of the health system, added to the poverty of population are reflected in the health of citizens of Vaslui district. Thus, deaths per 1.000 population in 2007 was 11,2, compared to the regional average of 10,8, while the infant mortality rate (deaths under 1 year per 1000 live births) was 16,1, compared to the regional average of 14,2 (Local Development Plan, GAL Colinele Tutovei, 2012).

1. It is very important how agriculture is practiced there. I designed a scheme below, regarding the ecological factors and their effects on crops, in order to establish a Sustainable Management Plan with measures to achieve better quality agriculture.

NEGATIVE, LIMITING AND STRESS ECOLOGICAL FACTORS

GEOCLIMATIC FACTORS

- low summer rainfall;
- pluvial erosion on slopes;
- torrential rain and hailstone;
- underground water in profile;
- stagnant rainwater;

PEDOLOGICAL FACTORS

- fine texture;
- poor aero-hydric regime;
- hard summer consistency;
- high plasticity on humid;
- compaction and consistency;
- low humus content
- vertic, stagnic, salic and alcalic processes.

ANTHROPOGENIC FACTORS

- lack of organic fertilizers;
- lack of irrigation;
- lack of unclogging;
- fallow ground cultivation;
- lack of foliar fertilization;
- lack of lightweight machines.

ECOLOGICAL AND ECONOMICAL NEGATIVE EFFECTS :

- excessive and prolonged summer drought;
- poor quality soil works;
- reduced biological activity;
- destruction of soil structure;
- decreased cultures density;
- soil compaction;
- surface erosion;
- depth erosion;
- small depth of seeding;
- poor quality of seeds;

SUSTAINABLE MANAGEMENT PLAN

(ECOLOGICAL MANAGEMENT PLAN)

SUSTAINABLE MANAGEMENT PLAN

1. TECHNOLOGICAL MEASURES

Land with excessive humidity

- ►scarification and aeration
- ►unclogging the canals
- ►organic fertilization
- ► foliar fertilization
- ►irrigation
- ►vegetable crops
- ►deep autumn plowing
- ►lightweight machines for seeding

Slope lands

- ►works on level curves
- ►culture on strips
- ►organic fertilization
- ►limited land works

Sandy soils

- ►organic fertilization
- ►chemical fertilization with small frequent doses
- ►irrigation with small doses

fallow ground tillage system

- ►should not sown directly on plowed fallow ground in the first year
- ►maintenance of land for one year by frequent plowing and disking

WORKING SCHEME:

Superficial disking → total herbicide → organic and mineral fertilization with PK → deep scarification and aeration → autumn plowing → spring disking → chemical fertilization → pre-emergent herbicide → spring sown with hoeing machines

2. ORGANIZATIONAL MEASURES

- ►providing a minimum of machinery and equipment for immediate intervention
- ►acquiring irrigation system
- ►unclogging drainage canals and their maintenance
- ►using extra quality seeds for cereals
- ►use of imported varieties and hybrids produced in similar ecological habitat, especially for autumn crops to resist on winter freezing
- ►creating their own maintenance spot for agricultural machines
- ►creating their own silage

3. ECONOMICAL MEASURES

- ►seed production in their own seed plots and using the seed
- ►creating conditions for processing their production and other sources of income to cover investment costs
- ►creating a small association to participate as a partner together with local authorities, research institutes and universities, in European projects, to get the *funds* for a good quality agriculture

4. SCIENTIFICAL MEASURES

- ► an optimum agricultural land use
- ►creating a small association to participate as a partner together with research institutes and universities, in European projects, to get *professional assistance* for a good quality agriculture

2. To prevent landslides, it can be establish several forest belts, to have a reasonable perspective of this area (Constandache, 2003; Pujină et al., 2005; 2010).

3. Hunting and fishing tourism. Hunting fauna of Vaslui County is diverse, allowing the unforgettable hunting. The main species of animals living in the forests are deer, wild boar (wild pigs) and hare (wild rabbits). Also they can hunt partridges, pheasants, wild ducks and foxes and other species. Vaslui Forestry Department has three hunting lodges providing accommodation and meals for tourists.

At Fichiteşti lake, can be create a fishing fund, which can get money and employment opportunities.

4. Atracting investors consist in providing facilities for investors. Regarding harnessing the resources, the community representatives suggest the recovering of alternative energy sources, especially the *wind potential* of these areas.

5. An important solution for this rural area is an optimum agricultural land use. The objective of this solution is to establish an appropriate methodology to identify the best land use pattern, based on the natural conditions, so that land planning and land treatment investments to be at minimum level.

According to Methodology of Pedological Studies Assessment (ICPA Bucharest, 1987 – Research Institute of Soil Science and Agrochemistry from Bucharest, Romania), the land suitability can be estimated by land evaluation rate – LER (table 30).

Table 30. The land use rate (ICPA, 1987-modified)

Class	Land evaluating rate (points)
I – very high	81 – 100
II – high	61 – 80
III – medium	41 – 60
IV – low	21 – 40
V – very low	1 – 20

The actual land use categories in the studied area are shown in figure 52. The agricultural lands covers 54,3% of total, pastures and meadows covers 21,55%, vineyards covers 3,76% and orchards covers 0,73%. The rest of 19,68% are non-agricultural lands.

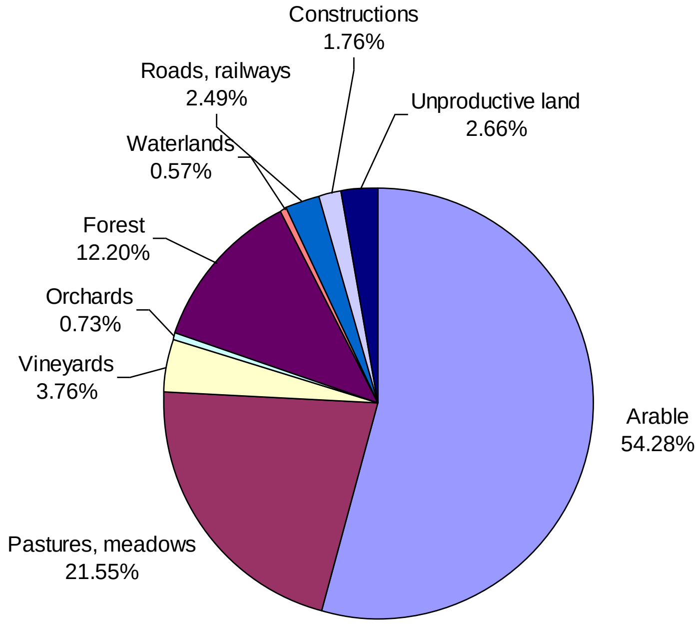

Figure 52. The actual land use categories in the studied area

According to the land evaluation rate for the main crops (figure 53), we can evaluate, pastures and meadows as having high suitability (LER 61,1), arable land and orchards having medium suitability (LER 46,3) and vineyards having low suitability (LER 33,2)

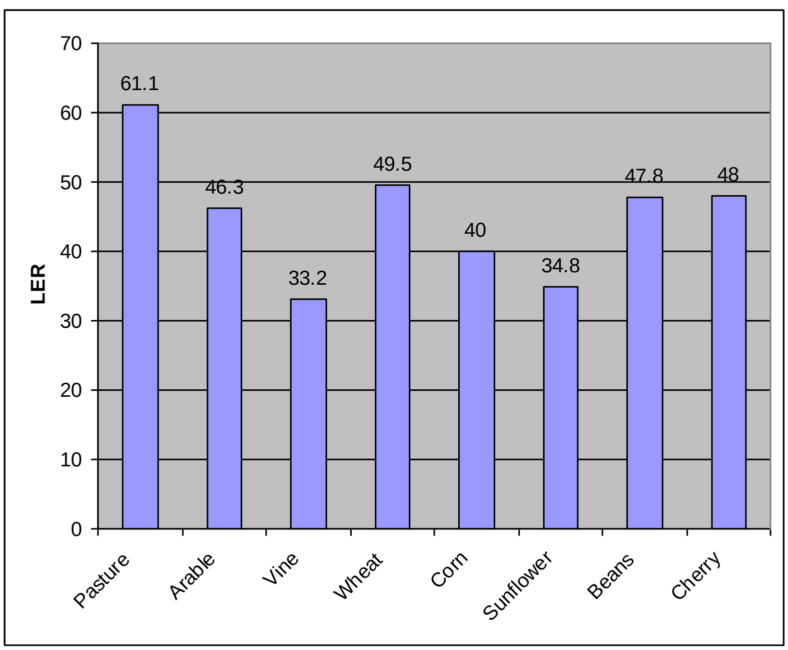

Figure 53. The land evaluation rate (LER) for the main crops in the studied area
(modified after Niacşu, 2012a)

Thus, the arable land is too extended and it is recommended to decrease from 54,3 % of the total area to only 28,7%. The pastures must slightly extend from 21,6% to 28,3%. Instead, the forestland should increase more than three times from 12,2% at present to 37,1% (Figure 54).

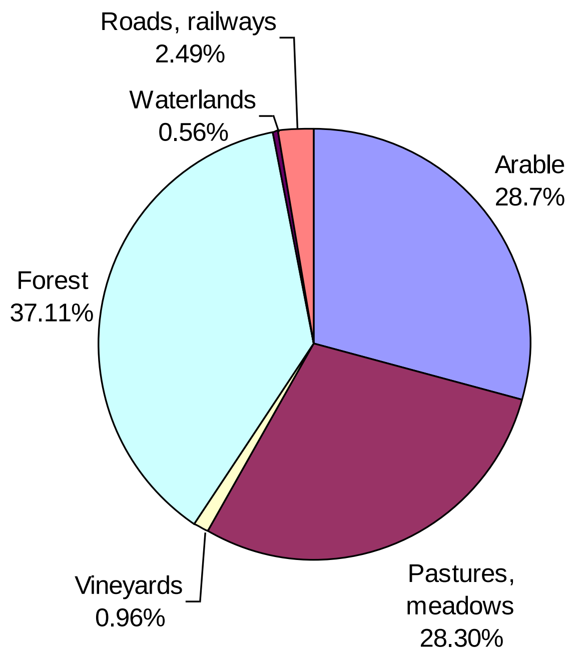

Figure 54. The new land use categories

Generally, in the lower Pereschiv basin, the people must shift towards large-scale livestock, an activity which currently supports only their domestic purposes. In the middle and lower catchment, livestock has to extend too, and alternate with crop farming on relatively large areas, but higher than today. In terms of sustained investments, vineyard and the orchard can achieve very good results.

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Annex 1

Sociological questionnaire: Commune Podu Turcului – Bacău county

I have investigated 74 persons representing 74 households (totally 458 persons). They were 369 adults and 89 minors (81 persons of age 3-18 and 8 persons of age 0-3).

Surname Name Age

1. Since when do you live in this village?
   Answer: Since I was born – 56
   5-10 years ago – 14
   10-15 years ago - 4

2. How many generation of your family lives here?
   1st – 18;
   2nd – 14;
   3rd – 38;
   4th – 4.

3. How many members are in your family?
   1 member – 14 (old people);
   2 members – 22 (old people);
   3 members – 21;
   4 members – 56;
   5 members – 60;
   6 members – 54;
   7 members - 49.

4. Which is the main occupation of the adults in your family?
   Agriculture – 186;
   Working by day – 9;
   Employees – 68 ;
   Own business – 12;
   Retired – 45;
   None – 8;
   No answer – 9.

5. Does the minors in your family goes to school?
   Yes – 81;
   No – 0.

6. Do you have access to electricity, gas, sewerage?
   Yes – 74 (all)

7. Do you grow animals in your household?
   Cows – 48;
   Sheep – 284;
   Goats – 78;
   Horses – 51;
   Hen – 380;
   Pigs – 110.

8. Which is the health status in your family?
   Good – 39;
   Poor – 14;
   Bad – 6.

9. In what proportion, the food consumed in your family is produced in your own household?
   100% - 32;
   80% - 42 (bread, vegetables, animal supplies).

10. How many members of your family consume alcohol and how often?
   They avoided to answer exactly, but most of them admited that adults consume alcohol, except children and some old people.

11. How many rooms do you have in your home and how many family members live in a room?
   1 room – 3;

2 rooms – 5;
3 rooms – 16;
4 rooms - 32;
5 rooms - 11;
More - 7.

12. The money income in your family:
Salary – 112;
Working by day – 9;
Selling food products from own household – 48;
Unemployment benefit – 9;
Child allowance – 76;
Pension – 45.

13. How much money has been spent last month in your household and on what?
0-50 RON: 6;
51-100 RON: 8;
101-150 RON: 9;
151-200 RON: 21;
More than 200 RON: 30.

14. How often do you travel outside your village and why?
Job – every day: 31;
Occasionally work – once or twice a week: 14;
Shopping – once a month or much rare: 11;
Very rare: 8.

Component localities:

1. Bălăneşti,
2. Căbeşti,
3. Fichiteşti,
4. Giurgioana,
5. Hanţa,
6. Lehancea,
7. Plopu,
8. Podu Turcului,
9. Răcuşana,
10. Sârbi.

The sociological research was made on 458 persons, having a margin of error of 1-2 %.

In Podu Turcului commune were recorded 2199 conventional homes, of which 2191 are private property and eight are state property. In this commune there are nine schools, three cultural houses and a communal library. The infrastructure of this commune includes sewage network and water, electricity and gas network. Also, there is the biggest hospital considered for this commune in a rural zone, with a capacity of 200 beds. The inhabitants deal with trade, agriculture, small crafts.

Sociological questionnaire: Commune Iveşti – Vaslui county; 52 households, 208 persons

Surname Name Age

1. Since when do you live in this village?
   Answer: Since I was born, 52

2. How many generation of your family lives here?
   1st – 0;
   2nd – 10;
   3rd – 39;
   4th – 3.

3. How many members are in your family?
   1 member – 9 (very old people);
   2 members – 12 (old people);
   3 members – 11;
   4 members – 5;
   5 members – 11;
   6 members – 2;
   7 members - 2.

4. Which is the main occupation of the adults in your family?
   Agriculture – 90;
   Working by day – 48;
   Employees – 8;
   Retired – 31;
   None – 9;
   No answer – 22.

5. Does the minors in your family goes to school?
   Yes – 14;
   No – 24.

6. Do you have access to electricity, gas, sewerage?
   Electricity – 51;
   Other facilities - 0

7. Do you grow animals in your household?
   Cows – 51;
   Sheep – 185;
   Goats – 60;
   Horses – 63;
   Hen – 284;
   Pigs – 99.

8. Which is the health state in your family?
   Good – 40;
   Poor – 11;
   Bad – 1.

9. In what proportion, the food consumed in your family is produced in your own household?
   100% - 48;
   80% - 4 (Most of them declared they buy bread time to time).

10. How many members of your family consume alcohol and how often?

They avoided to answer exactly, but most of them admited that adults consume alcohol almost every day, except children and some old people.

11. How many rooms do you have in your home and how many family members live in a room?
   1 room – 18
   2 rooms – 25
   3 rooms – 9

12. The money income in your family:
   Salary – 12;
   Working by day – 48;
   Selling food products from own household – 33;
   Unemployment benefit – 11;
   Child allowance – 31;
   Pension – 28.

13. How much money has been spent last month in your household and on what?
   0- 50 RON: 11;
   51-100 RON: 13;
   101-150 RON: 26;
   151-200 RON: 2.

14. How often do you travel outside your village and why?

Job – every day: 8;

Occasionally work – once or twice a week: 16;

Shopping – once a month or much rare: 24;

Very rare: 4.

Component localities: only Iveşti village.

In Iveşti commune were recorded 1059 conventional homes, of which 1056 are private property and three are state property.

The sociological research was made on 208 persons, having a margin of error of 1-2 %.

Sociological questionnaire: Commune Bogheşti – Vrancea county; 48 households, 198 persons

Surname Name Age

1. Since when do you live in this village?
   Answer: Since I was born: 48.

2. How many generation of your family lives here?
   1st – 0;
   2nd – 9;
   3rd – 36;
   4th – 3.

3. How many members are in your family?
   1 member – 7 (very old people);
   2 members – 8 (old people);
   3 members – 9;
   4 members – 11;
   5 members – 12;
   6 members – 0;
   7 members - 1.

4. Which is the main occupation of the adults in your family?
   None – 5;
   Agriculture – 95;
   Working by day – 6;
   Retired – 23;
   Employees – 6;
   No answer – 8.

5. Does the minors in your family goes to school?
   Yes – 14;
   No – 9.

6. Do you have access to electricity, gas, sewerage?
   Electricity – 40;
   Other facilities - 0

7. Do you grow animals in your household?
   Cows – 32;
   Sheep – 114;
   Goats – 29;
   Horses – 28;
   Hen – 189;
   Pigs – 58.

8. Which is the health state in your family?
   Good – 36;
   Poor – 10;
   Bad – 2.

9. In what proportion, the food consumed in your family is produced in your own household?
   100% - 41;
   80% - 7 (Most of them declared they buy bread time to time).

10. How many members of your family consume alcohol and how often?
   They avoided to answer exactly, but most of them admited that adults consume alcohol almost every day, except children and some old people.

11. How many rooms do you have in your home and how many family members live in a room?
   1 room – 9
   2 rooms – 36
   3 rooms – 3

12. The money income in your family:
   Salary – 6;
   Working by day – 13;
   Selling food products from own household – 11;
   Unemployment benefit – 5;
   Child allowance – 6;
   Pension – 7.

13. How much money has been spent last month in your household and on what?
   0- 50 RON: 11;

51-100 RON: 3;
101-150 RON: 19;
151-200 RON: 15.

14. How often do you travel outside your village and why?

Job – every day: 1;
Occasionally work – once or twice a week: 12;
Shopping – once a month or much rare: 10;
Very rare: 25.

Component localities:

1. Bogheşti
2. Bogheştii de Sus
3. Bicheşti
4. Prisecani
5. Tabuceşti
6. Pleşeşti
7. Iugani
8. Chiţcani
9. Plăcinteni.

The sociological research was made on 198 persons number of people, having a margin of error of 1-2 %.

The Bogheşti infrastructure is formed mostly of stone roads and only 2 km of paved roads. It was established by the national census that the poverty rate in Bogheşti commune is 65%, one of the highest in the country. In Bogheşti commune were recorded 869 conventional homes, of which 862 are private property and seven are state property.

Sociological questionnaire: Commune Priponeşti – Galaţi county; 50 households, 201 persons

Surname Name Age

1. Since when do you live in this village?
   Answer: Since I was born: 50.

2. How many generation of your family lives here?
   1st – 16;
   2nd – 27;
   3rd – 44;
   4th – 60.

3. How many members are in your family?
   1 member – 15 (old people);
   2 members – 8 (old people);
   3 members – 12;
   4 members – 11;
   5 members – 18.

4. Which is the main occupation of the adults in your family?
   Agriculture – 95;
   Working by day – 6;
   Employees – 6;
   Retired – 23;
   None – 5;
   No answer – 8.

5. Does the minors in your family goes to school?
   Yes – 16;
   No – 8.

6. Do you have access to electricity, gas, sewerage?
   Electricity – 49;
   Other facilities - 0

7. Do you grow animals in your household?
   Cows – 41;
   Sheep – 105;
   Goats – 21;
   Horses – 30;
   Hen – 198;
   Pigs – 48.

8. Which is the health state in your family?
   Good – 34;
   Poor – 11;
   Bad – 5.

9. In what proportion, the food consumed in your family is produced in your own household?
   100% - 40;
   80% - 10 (Most of them declared they buy bread time to time).

10. How many members of your family consume alcohol and how often?
   They avoided to answer exactly, but most of them admited that adults consume alcohol almost every day, except children and some old people.

11. How many rooms do you have in your home and how many family members live in a room?
   1 room – 8;
   2 rooms – 31;
   3 rooms – 11.

12. The money income in your family:
   Salary - 5
   Working by day – 14;
   Selling food products from own household – 12;
   Unemployment benefit – 5;
   Child allowance – 9;
   Pension – 5.

13. How much money has been spent last month in your household and on what?
   0- 50 RON: 9;
   51-100 RON: 4;

101-150 RON: 20;
151-200 RON: 17.

14. How often do you travel outside your village and why?
Job – every day: 2;
Occasionally work – once or twice a week: 14;
Shopping – once a month or much rare: 17.

Component localities:

1. Ciorăşti,
2. Lieşti,
3. Priponeşti,
4. Priponeştii de Jos.

The sociological research was made on 198 persons, having a margin of error of 1-2 %. In Priponeşti commune were recorded 1194 conventional homes, of which 1178 are private property and 16 are state property.